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ECONOMIC GEOGRAPHY

OCTOBER

THE HARBORS OF AFRICA
George F. Deasy

AGRICULTURAL REGIONS OF AFRICA
H. L. Shantz

HAIL IN AMERICAN AGRICULTURE
Hoyt Lemons

CHANGES IN LAND UTILIZATION ON THE PLATEAU OF NORTHWESTERN COLORADO
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INDIAN LAND IN THE CHEROKEE COUNTRY OF OKLAHOMA
Leslie Hewes

MICHIGAN LIMESTONE IN THE GREAT LAKES STONE TRADE
Paul Cross Morrison

LARK UNIVERSITY, WORCESTER, MASSACHUSETTS, U.S.A.

OUR CONTRIBUTORS

Mr. Deasy, formerly Instructor in Geography at the University of Cincinnati and Junior Geographer in the United States Department of State, is at present actively and directly engaged in the war effort in Washington. A number of his articles have appeared in recent issues of ECONOMIC GEOGRAPHY.

Dr. Shantz, now Chief of the Division of Wildlife Management, Forest Service, U. S. Department of Agriculture, has long been engaged in problems connected with agriculture. He has written extensively on the vegetation of the Great Plains and other semi-arid regions. With the late Dr. Curtis F. Marbut he wrote, *The Vegetation and Soils of Africa*, one of the monographs issued by the American Geographical Society, and still the authority in the field of Africa.

Dr. Lemons, Assistant Professor of Geography at Oklahoma A. & M. College, has written several articles on climatology, his particular field of interest. His present article is the result of considerable recently-conducted research on hail and agriculture.

Dr. Davis, who received his doctorate from the University of Michigan, and is now Assistant Professor of Geography at his Alma Mater, specializes in the utilization of waste and submarginal, and underpopulated lands. He has already contributed several articles to ECONOMIC GEOGRAPHY.

Dr. Hodgen, Chairman of the Department of Social Institutions of the University of California at Berkeley, has written several articles on geographical and historical aspects of social institutions which have been published in various scientific journals.

Dr. Hewes, Assistant Professor of Geography at the University of Oklahoma, has already contributed two articles to earlier issues of ECONOMIC GEOGRAPHY.

Dr. Morrison, Assistant Professor of Geography at Michigan State College, has engaged in much study of the limestone industry of Michigan. This is the second article on the subject published in ECONOMIC GEOGRAPHY, the first, *Michigan Limestone Industry*, having appeared in the July 1942 issue.

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ECONOMIC GEOGRAPHY

CONTENTS FOR OCTOBER, 1942

THE HARBORS OF AFRICA 325
GEORGE F. DEASY

AGRICULTURAL REGIONS OF AFRICA. PART III. PRESENT AND POTENTIAL PRODUCTIVITY OF THE LAND (*Continued*) 343
H. L. SHANTZ

HAIL IN AMERICAN AGRICULTURE 363
HOYT LEMONS

CHANGES IN LAND UTILIZATION ON THE PLATEAU OF NORTHWESTERN COLORADO 379
CHARLES M. DAVIS

FAIRS OF ELIZABETHAN ENGLAND 389
MARGARET T. HODGEN

INDIAN LAND IN THE CHEROKEE COUNTRY OF OKLAHOMA 401
LESLIE HEWES

MICHIGAN LIMESTONE IN THE GREAT LAKES STONE TRADE 413
PAUL CROSS MORRISON

BOOK REVIEWS 428

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HAIL

HAIL as a factor in farm economy has never been fully appreciated by the public at large, however ominous it may have loomed as possibility of catastrophe for the farmer. In the course of a few moments of thunderstorm violence, the farmer may see the fruits of months of planning and care and labor seriously damaged, or even wholly destroyed.

Fortunately, areal distribution of hail as a potential destructive force in agriculture is relatively limited, not nearly so widespread as crops that might be damaged or destroyed, and it is not of regular recurrence. Very few regions are affected throughout their major extent—the areas of hail damage are generally restricted to narrow strips and limited range. Very few such areas suffer hail frequently—the areas of hail damage, except in a few localities, are subject to hail only intermittently, often at intervals of years.

Yet the problem of hail damage and destruction, of hail insurance and protection, deserves more attention than it has hitherto received. It is well to know where hail is serious deterrent to successful crop production, and where it is negligible as hazard in the farm economy. Its distribution and consequences merit more study.

ECONOMIC GEOGRAPHY

VOL. 18 OCTOBER, 1942 No. 4

THE HARBORS OF AFRICA

George F. Deasy

DURING the ensuing months, Africa is likely to come to the fore as one of the significant scenes of activity in the present world conflict. African harbors and ports will then become objects of world-wide interest. Already, certain entryways into the continent have received considerable attention, and Americans to whom the names of African harbors were strange and unknown are now talking glibly about Dakar, Tobruk, Suez, Bengasi, Bathurst, Freetown, Capetown, Alexandria, Port Said, and other African coastal towns. The North African military campaigns, the shipment of American supplies to the Near East via the Indian Ocean, the necessity for British ships to circumnavigate Africa, the Free French campaign in West Africa, the use of African ports as stops along the Brazilian-African Allied supply route—all these events have focused the American mind on the subject of African ports to an extent heretofore unknown.

United States interest in African harbors will not be ephemeral, however. Intensive utilization of the tremendous potential resources of that continent is certain to develop during the post-war years, and trade will expand many fold. Consequently, the harbors of Africa will lose their former provincial status and will become a matter of international concern. (See article on Africa in *Fortune*, Vol. 24, No. 5, Nov. 1941.)

Because of the present military significance of African ports, and their probable future increased commercial importance, it would seem that an examination of the harbor facilities of that continent would not be amiss. In this study, open-roadstead ports will not be considered, even though they are occasionally of some commercial significance. (Accra and Sekondi, on the Gold Coast, for instance.) Instead, attention will be confined to the *harbors* of Africa, for they are after all of major consequence both for the military campaigns that are being conducted today and for the expanded peace-time trade that will develop when this war is over.

AN OVERVIEW

Scattered along the 16,000 miles of coastline that margins Africa (this and all subsequent figures that relate to length of coastline exclude all but the major coastal indentations) is a series of eighty-eight first-class harbors. Each is (1) well protected from wind and sea on all sides, (2) spacious enough to accommodate a considerable number of large, ocean-going vessels simultaneous-

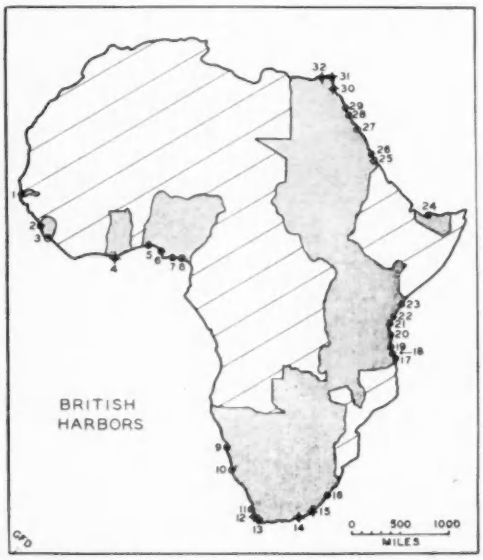


FIGURE 1.—All first-class harbors in British African territory are shown. The open circles represent undeveloped natural harbors; the solid black circles are developed natural harbors; the solid black circles with radiating lines indicate developed artificial harbors. The number opposite each harbor corresponds to the same number in the list of British harbors contained in the text.

ly, and (3) sufficiently deep to permit access to many of the vessels plying the ocean today. (The average steamer draws about 20 to 25 feet of water when loaded. Large liners usually draw from 30 to 35 feet of water. The smallest ocean-going steamers draw 15 feet or more. Hence, harbors with a minimum depth of less than 15 feet in the channel of approach and in the anchorage, at mean low tide, have been considered unfit for modern vessels.) No coastal embayment, either natural or man-made, that fails to meet all three requirements can rightfully be considered a first-class harbor. If it is unprotected against sea and wind from any direction it is not suitable for year-round use, for when strong winds blow from the open ocean ships must evacuate the harbor and operations are suspended. Shallow embayments are obviously unavailable to modern vessels and a coast with such features is scarcely more inviting than a linear shore. Small and narrow embayments likewise cannot rank as first-class harbors, even though they may be both deep and well-protected.

Manifestly, the eighty-eight African harbors that meet the above three requirements are not all of similar character and equal value. There is almost infinite variety in the combinations of depth, size, shape, degree of shelter, and ease of access. Minimum depths range from 15 feet to more than 60 feet. Some harbors are elongated, others have an oval or irregular shape. Some cover a fraction of a square mile while others are many times that size. There are, therefore, all kinds of harbors ranging from excellent down to fair.

Similarly, all the harbors of Africa are not equally well equipped. For instance, the highly developed harbors of the Moroccan, Algerian, and Tunisian coasts, with their complex and costly port facilities (docks, wharves, warehouses, loading and unloading facilities, refueling and repair equipment, et cetera) contrast strikingly with the almost undeveloped harbors of most of Mozambique and Angola, where port facilities are meager or completely lacking.

Marked differences can likewise be noted between the Mediterranean coast of North Africa, where almost every harbor has been constructed by man (i.e., protection is provided by piers and breakwaters) under the incentive of profitable trade or military necessity, and the shores of tropical Africa where either adequate natural harbors are available or where the importance of trade has not warranted the construction of more than a few artificial harbors.

Considerable diversity exists in the harbor facilities of the various sections of the African coast. Some of the more

favored coasts include: (1) the western half of the North African shore, comprising northern Morocco, Algeria, and Tunisia (16 harbors), (2) the West African coast, south from Dakar to northern Liberia (8 harbors), (3) southern Angola (6 harbors), and (4) the Indian Ocean coast, from central Mozambique northward along Tanganyika and Kenya to the boundary of Italian Somaliland (14 harbors). Along such coastal sections, harbors are generally spaced from twenty to one hundred miles apart, which is sufficiently frequent to offer adequate commercial outlets to the adjacent hinterlands, either for present or future development.

African coasts that are particularly deficient in first-class harbors (both natural and man-made) include: (1) Northwest Africa, from middle Morocco south to Dakar, with two harbors along some 1,800 miles of coast; (2) the 1,200 mile coastline between western Liberia and western Nigeria, with but one first-class harbor (Takoradi); (3) the coast of Southwest Africa, with two harbors; (4) the 1,900 mile coastline of Italian and British Somaliland, which has only three harbors, and (4) the Egyptian and Libyan coasts west of Alexandria, where there are only three harbors. These less-favored coastal sections lack harbor facilities for distances as great as 500 to 1,500 miles. Obviously, their hinterlands are confronted with a distinct handicap.

POLITICAL DISTRIBUTION OF AFRICAN HARBORS

Great Britain has thirty-two first-class harbors in Africa, which is more than any other power (Figure 1). With approximately thirty-seven per cent of the total African coastline under her control, however, she possesses no more than the expected allotment from the eighty-eight harbors. In general, Britain's African possessions are well supplied with harbors, and where adequate natural facilities are lacking the deficiency has been remedied by the construction of artificial ones (Takoradi, Capetown, Port Elizabeth, East London, Suez, Port Said, and Alexandria). The poorest area from the standpoint of accessibility from the sea, the coast of Southwest Africa, is fortunately of least economic value. Regions with the most adequate array of harbors include Kenya and Tanganyika, the Red Sea coast of Egypt, the Cape of Good Hope area, and Nigeria.

The following table indicates the political distribution and character of Britain's African harbors (the initial figure before each harbor name refers to the same number in Figure 1).

TABLE I

GAMBIA:
1. Bathurst: 25 feet,* natural,** developed.***

SIERRA LEONE:
2. Freetown: 36 feet, natural, developed.
3. Sherbro River: 25 feet, natural, undeveloped.

GOLD COAST:
4. Takoradi: 25 feet, artificial, developed.

NIGERIA:
5. Lagos: 25 feet, natural, developed.
6. Forcados: 17 feet, natural, developed.
7. Port Harcourt: 21 feet, natural, developed.
8. Calabar: 20 feet, natural, developed.

SOUTHWEST AFRICA:
9. Walvis Bay: 29 feet, natural, developed.
10. Luderitz Bay: 24 feet, natural, undeveloped.

UNION OF SOUTH AFRICA:
11. Saldanha Bay: 24 feet, natural, undeveloped.
12. Capetown: 35 feet, artificial, developed.
13. Simons Bay: 24 feet, artificial, developed.
14. Port Elizabeth: 60 feet, artificial, developed.
15. East London: 28 feet, artificial, developed.
16. Durban: 31 feet, natural, developed.

TANGANYIKA:
17. Mikindani: 30 feet, natural, undeveloped.
18. Lindi: 30 feet, natural, undeveloped.
19. Kilwa: 54 feet, natural, undeveloped.
20. Dar es Salaam: 20 feet, natural, developed.
21. Tanga: 20 feet, natural, undeveloped.

KENYA:
22. Mombasa: 33 feet, natural, developed.
23. Manda Bay: 34 feet, natural, undeveloped.

BRITISH SOMALILAND:
24. Berbera: 30 feet, natural, undeveloped.

ANGLO-EGYPTIAN SUDAN:
25. Suakin: 42 feet, natural, undeveloped.
26. Port Sudan: 63 feet, natural, developed.

EGYPT:
27. Port Berenice: 40 (?) feet, natural, undeveloped.
28. Port Safâga: 24 feet, natural, undeveloped.
29. Gubbet ti Gimsah: 24 feet, natural, undeveloped.
30. Suez: 30 feet, artificial, developed.
31. Port Said: 30 feet, artificial, developed.
32. Alexandria: 36 feet, artificial, developed.

*Figures refer to approximate minimum depth in channel of approach and at anchorage during mean low tide.

**"Natural" harbors depend upon the configuration of

the coastline for protection against wind and wave; "artificial" harbors depend primarily upon piers and breakwaters for such protection. Many "natural" harbors have, of course, been deepened by man.

***"Developed" harbors have fair to good port facilities, which include some or all of the following: wharves, storage facilities, loading and unloading equipment, means for repairing vessels, and available fuel and water supplies. "Undeveloped" harbors have few or none of these facilities.

FIGURE 2.—All first-class harbors in Portuguese and Belgian African territories are shown. The open circles represent undeveloped natural harbors; the solid black circles indicate developed natural harbors. There are no artificial harbors. The number or letter opposite each harbor corresponds to the same number or letter in the lists of Portuguese and Belgian harbors contained in the text.

Portugal (Figure 2) possesses twenty-two African harbors, including some of the best on the continent. Even the minute colony of Portuguese Guinea has three good natural harbors, while Angola has seven and Mozambique is blessed with twelve deep, sheltered embayments. Northern Mozambique offers one of the outstanding examples of a "super-abundance" of fine harbors; seven excellent bays are there concentrated along a three-hundred-mile coastline.

Portugal, however, has made less use of her African harbors than any other colonial power. A few ports have been developed, it is true (Lourenço Marques, Lobito, Luanda, etc.), but sixteen of her twenty-two harbors still are almost unused, awaiting the time when the demands of commerce will bring them to life. With such undeveloped potentialities, it is understandable why no artificial harbors have been constructed by the Portuguese.

The following table indicates the political distribution and character of Portugal's African harbors (the initial figure before each harbor name refers to the same number in Figure 2).

TABLE II

PORTUGUESE GUINEA:
1. Cacheu River: 15 feet,* natural,** undeveloped.***
2. Bissau River: 33 feet, natural, developed.
3. Bolama River: 54 feet, natural, undeveloped.

CABINDA:

ANGOLA:
4. Luanda: 42 feet, natural, developed.
5. Lobito: 30 feet, natural, developed.
6. Farta Bay: 64 feet, natural, undeveloped.
7. Elephant Bay: 60 feet, natural, undeveloped.
8. Mossámedes: 36 feet, natural, undeveloped.
9. Porto Alexandre: 60 feet, natural, undeveloped.
10. Great Fish Bay: 60 feet, natural, undeveloped.

MOZAMBIQUE:
11. Lourenço Marques: 25 feet, natural, developed.
12. Inhambane: 18 feet, natural, developed.
13. Bazaruto Bay: deep, natural, undeveloped.
14. Beira: 23 feet, natural, developed.
15. Quelimane: 18 feet, natural, undeveloped.
16. Mokambo Bay: 54 feet, natural, undeveloped.
17. Moçambique: 20 feet, natural, undeveloped.
18. Porto Nakala: deep, natural, undeveloped.
19. Memba Bay: deep, natural, undeveloped.
20. Porto Amelia: 66 feet, natural, undeveloped.
21. Ibo: 30 feet, natural, undeveloped.
22. Mocimboa Bay: 33 feet, natural, undeveloped.

* ** ***For explanation of terms, see table for Great Britain's African ports.

French colonial possessions in Africa are poorly supplied with natural harbor facilities (Figure 3). Although possessing the largest African empire, with approximately twenty-three per cent of the coastline of the continent and some of the most productive hinterland, France has only nine naturally sheltered embayments.

The French have partially remedied the deficiency by constructing thirteen excellent artificial harbors, a number larger than that of all other sections of Africa combined. Thus they have completely remade the coastline of

French North Africa, changing it from one almost devoid of shelter for large, modern vessels to one of the two most accessible stretches of coast on the continent, comparable to and even surpassing that of northern Mozambique. Nine artificial harbors, plus two that are natural, now give Algeria and Tunisia adequate contact with the sea and the mother country. Much of the remainder of French Africa, however, is still woefully poor in harbors, even with the completion of Dakar, Pointe Noire, and Djibouti. The Ivory Coast, Dahomey, and Togoland are without sheltered embayments, and most of the remaining sections of the coast have only one or two widely-spaced harbors.

The following table indicates the political distribution and character of French African harbors (the initial figure before each harbor name refers to the same number in Figure 3).

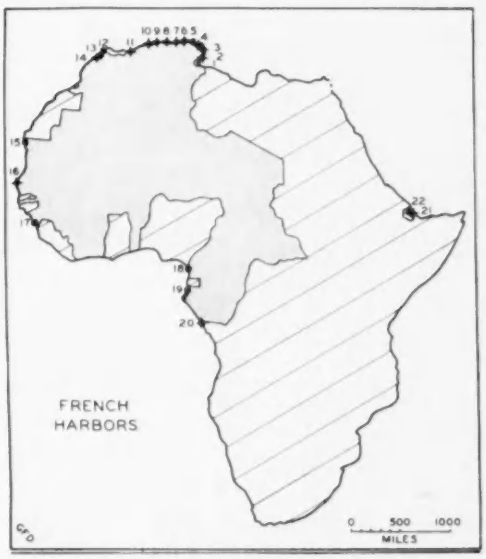


FIGURE 3.—All first-class harbors in French African territory are shown. The open circles represent undeveloped natural harbors; the solid black circles are developed natural harbors; the solid black circles with radiating lines indicate developed artificial harbors. The number opposite each harbor corresponds to the same number in the list of French harbors contained in the text.

TABLE III

TUNISIA:
1. Sur Kenis Bay: 24 feet,* natural,** undeveloped.***
2. Sfax: 21 feet, artificial, developed.
3. Sousse: 20 feet, artificial, developed.
4. Tunis: 20 feet, artificial, developed.
5. Bizerte: 32 feet, natural, developed.

ALGERIA:
6. Bône: 32 feet, artificial, developed.
7. Philippeville: 23 feet, artificial, developed.
8. Djidjelli: 22 feet, artificial, developed.
9. Bougie: 31 feet, artificial, developed.
10. Alger: 30 feet, artificial, developed.
11. Oran: 26 feet, artificial, developed.

FRENCH MOROCCO:
12. Port Lyautey: 15 feet, natural, developed.
13. Rabat-Salé: 15 feet, natural, developed.
14. Casablanca: 22 feet, artificial, developed.

MAURITANIA:
15. Levrier Bay: 39 feet, natural, undeveloped.

SENEGAL:
16. Dakar: 27 feet, artificial, developed.

FRENCH GUINEA:
17. Conakry: 18 feet, natural, developed.

IVORY COAST;
TOGOLAND AND DAHOMEY;
CAMEROONS;
18. Douala: 21 feet, natural, developed.

FRENCH EQUATORIAL AFRICA:
19. Libreville: 24 feet, natural, undeveloped.
20. Pointe Noire: deep, artificial, developed.

FRENCH SOMALILAND:
21. Djibouti: 24 feet, artificial, developed.
22. Ghubbet Karab: 64 (?) feet, natural, undeveloped.

* ** ***For explanation of terms, see table for Great Britain's African ports.

Italian and Spanish colonies in Africa, despite their long shorelines, are extremely deficient in good harbors, having only seven and three respectively. Furthermore, half of these remain almost unutilized because of the arid, unproductive hinterlands. The three Italian and two Spanish harbors that have port facilities are all man-made structures and were built for military more than commercial reasons.

TABLE IV

LIBYA:
1. Tripoli: 24 feet,* artificial,** developed.***
2. Bengasi: 26 feet, artificial, developed.
3. Tobruk: 30 feet, natural, undeveloped.

ERITREA:
4. Annesley Bay: 54 (?) feet, natural, undeveloped.
5. Assab: 36 (?) feet, natural, undeveloped.

ITALIAN SOMALILAND:
6. Mogadiscio: artificial, developed.
7. Chisimaio: 20 feet, natural, undeveloped.

SPANISH MOROCCO:
A. Melilla: 27 feet, artificial, developed.
B. Ceuta: artificial, developed.

IFNI:
SPANISH SAHARA:
C. Rio de Oro: 17 feet, natural, undeveloped.

RIO MUNI:

* ** ***For explanation of terms, see table for Great Britain's African ports.

TABLE V

HARBORS OF AFRICA—POLITICAL DISTRIBUTION*

Colonial Possessions in Africa	*Approx. Per Cent of Total African Coastline*	*Total Number First-Class Harbors*	*Developed Harbors*	*Undeveloped Harbors*	*Artificial Harbors*
British	37%	32	19	13	8
Portuguese	15%	22	6	16	0
French	23%	22	18	4	13
Italian	17%	7	3	4	3
Spanish	7%	3	2	1	2
Belgium	less than 1%	2	2	0	0
		88	50	38	26

*Liberia and the Tangier Zone together possess about two per cent of the coastline of Africa, but no first-class harbors.

Table IV indicates the political distribution and character of Italian and Spanish African harbors (the initial figure before each harbor name refers to the same number in Figure 4).

Belgian Congo has two developed harbors on the Congo River estuary, Boma and Matadi (A and B in Figure 2). *Liberia* and the *Tangier Zone* have no sheltered embayments.

REPRESENTATIVE HARBORS AND PORTS

It would be impossible adequately to treat the eighty-eight African harbors individually and do each one justice in an article of this length. As an alternative, a score of more or less representative harbors and ports has been selected for discussion. Some are natural, others are artificial, still others are gradational between the two extremes. Selections have been made to represent both developed and undeveloped harbors, river-mouth, off-shore bar, delta, and structural-basin harbors, large harbors and small ones, deep and shallow ones. Three open-roadstead ports have been included for comparison, two of which are entirely unsheltered while the other is partly sheltered.

Maps of all twenty of the ports and harbors have been constructed. Unfortunately, a uniform scale could not be maintained, so that it is necessary to examine the scale of each map before attempting to evaluate the harbor or port shown.

Attention will be confined in the following paragraphs to the factors of site as they relate to each harbor or port. The broader aspects of situation, which affect the world relations and economic development of the various harbors, have been adequately treated elsewhere and will not be considered here.

The harbor of *Douala*, in the French mandate of Cameroon, is situated near the head of the estuary of the drowned Cameroon River. (Figure 6.) The outer harbor, more than ten miles wide and with depths exceeding 30 feet over a considerable area, rapidly narrows to approximately one mile in the inner harbor, near the port. A 15-foot channel, about one-third of a mile wide, extends up the Cameroon River beyond Douala. Dredging helps maintain this depth and extends an arm to the wharves so that vessels drawing 21 feet can tie up for loading and unloading. Plans have been made to deepen the estuary channel to handle ships of 28 feet draft. Port facilities are fair, and include several cranes and warehouses.

This harbor is typical of a whole series of estuary harbors on the northwest coast of Africa, including Port Lyautey and Rabat-Salé of French Morocco, Bathurst at the drowned

mouth of the Gambia River, the Portuguese Guinea harbors at the mouths of the Cacheu, Bissau, and Bolama Rivers, Conakry in French Guinea, Freetown on the estuary of the Rokelle River, the Sherbro River estuary of Sierra Leone, and the three Niger River distributary ports of Forcados, Port Harcourt, and Calabar. It likewise finds counterparts among more distant African harbors.

Alexandria (Figure 6) is located at the extreme western edge of the Nile delta, to avoid the silt swept eastward from the Nile distributaries by ocean currents. When founded by Alexander in 332 B.C., the town was built on the small island of Pharos, lying just off-shore from the delta. The modern city has expanded onto the long, narrow bar situated between the Mediterranean Sea and Lake Mariut, and the island has been connected to the bar by an artificial isthmus of silt, half a mile wide, to form a T-shaped peninsula. The modern West and East Harbors are separated and partly protected by this peninsula. Additional protection for the West Harbor is furnished by a two-mile long breakwater and a mile and one-half long pier (Figure 10). The East Harbor, open to the north, is only of local importance. With a protected harbor, measuring a mile by three-quarters of a mile and dredged to a depth of 36 feet, and possessing excellent facilities, Alexandria is one of the best ports of North Africa. It is, moreover, unique among African harbors, both in its semi-artificial character and its location on an off-shore bar of a delta.

Capetown (Figure 6) is an entirely artificial harbor, despite its location on Table Bay. This embayment, although deep and broad, is completely open to the north and exposed to the northwest winds of winter, which often reach gale strength. Furthermore, strong southeast winds of summer pass unobstructed

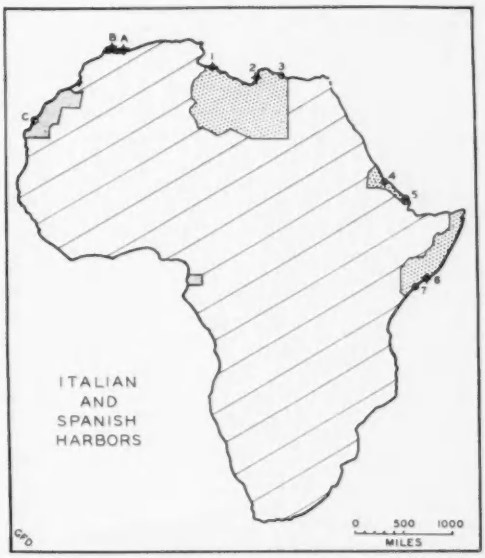


FIGURE 4.—All first-class harbors in Italian and Spanish African territories are shown. The open circles represent undeveloped natural harbors; the solid black circles are developed natural harbors; the solid black circles with radiating lines indicate developed artificial harbors. The number or letter opposite each harbor corresponds to the same number or letter in the lists of Italian and Spanish harbors contained in the text.

across the low flats which border the bay to the south. Consequently, a completely artificial harbor with several miles of breakwater now protects shipping and takes the place of the unsatisfactory natural embayment (Figure 11). Vessels drawing 35 feet of water can enter the main or west basin. Excellent port equipment for many purposes is available, including warehouses, pre-cooling rooms, a grain elevator, refueling and repairing facilities, and a dry dock.

Capetown finds counterparts at Port Elizabeth, where an artificial harbor is required despite a position on Algoa Bay, at Bône, Algeria, on the open Gulf of Bône, and at several other North African ports where similar partly-sheltered bays abound.

Suez (Figure 6), at the head of the Gulf of Suez, was formerly the ranking port of Egypt on the Red Sea. Today it is separated from the Suez Canal by

a sand bank almost two miles wide, and although a small canal has been cut through the sand it is too shallow (6 feet) to admit large vessels. The true southern terminus of the Canal is Port Taufig, outport of Suez and connected to it by a railroad running across the sand flats on an embankment. Port Taufig has one of the world's most "artificial" harbors; protection to shipping is man-made on all sides. The harbor is rather small (only one-half mile wide) since it is primarily a transit port for the Canal, but it has a depth of 30 feet and excellent facilities, particularly for refueling ships. No other port like it exists in Africa.

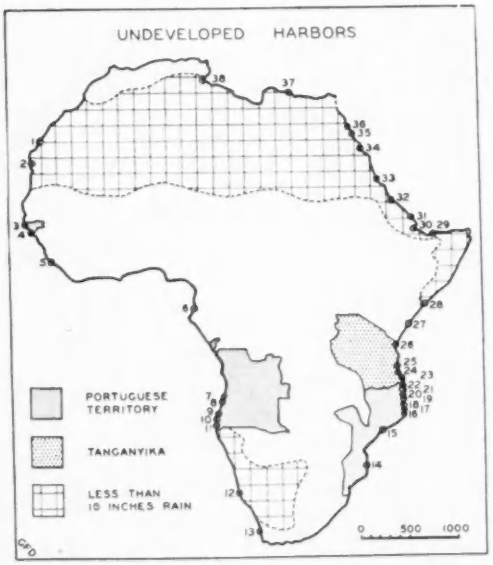


FIGURE 5.—Every undeveloped first-class harbor in Africa is shown in the above map. All but four of the thirty-eight undeveloped harbors are located in two characteristic positions: (1) on shorelines that border regions of less than ten inches annual precipitation, and (2) along the coasts of Portuguese colonies and Tanganyika. In the first mentioned regions, limited economic possibilities do not render feasible the expenditure of the necessary sums of money to supply harbors with docks, warehouses, machinery, etc. In Portuguese African territory, harbor facilities remain largely unused because of the financial inability of the mother country to develop the economic potentialities of its colonies. Harbors in Tanganyika have likewise remained largely unused because of the retarded economic development of the protectorate. (There is a noticeable tendency in British colonial policy for the interests of Kenya Colony to prevail against those of Tanganyika Protectorate, whenever preference is possible.)

Lagos (Figure 6), together with its outport, Apapa, is by far the best and most developed of the harbors of Nigeria. Situated on a relatively deep tidal inlet which affords access to the sheltered waters behind an off-shore bar, the entrance channel has been dredged since 1925 to maintain a minimum depth of 24 feet. (In 1907, the minimum depth was 11 feet; this was subsequently increased to 20 feet and then to 24 feet.) Two mile-long jetties help retain this depth. Today, ships of 8,000 tons, 450 feet long, and drawing 24 feet of water can tie up alongside the deep-water wharves at Apapa, and a score of large vessels can be accommodated there simultaneously. Port facilities are good, especially at Apapa, and rail connections on the wharves, loading and unloading apparatus, storage space, fuel, and water are all available.

No other African harbor is identical with Lagos, although several opportunities exist to construct similar shelters along the lagoon-fringed coast between Sierra Leone and the Niger delta. The French are reported to be considering a similar arrangement at Abidjan, on the Ivory Coast, but this will be discussed later.

Durban (Figure 6) occupies the northern rim of the large, oval Bay of Natal, the sole significant natural shelter along the eastern shore of the Union of South Africa. This embayment was formerly obstructed by a sand bar at its mouth and was rather shallow, but the bar has been partly removed and the harbor dredged so that now vessels drawing 35 feet of water (20,000 gross tons) can enter and maneuver freely. Continued excavation is necessary, however, to maintain these depths. Two jetties,

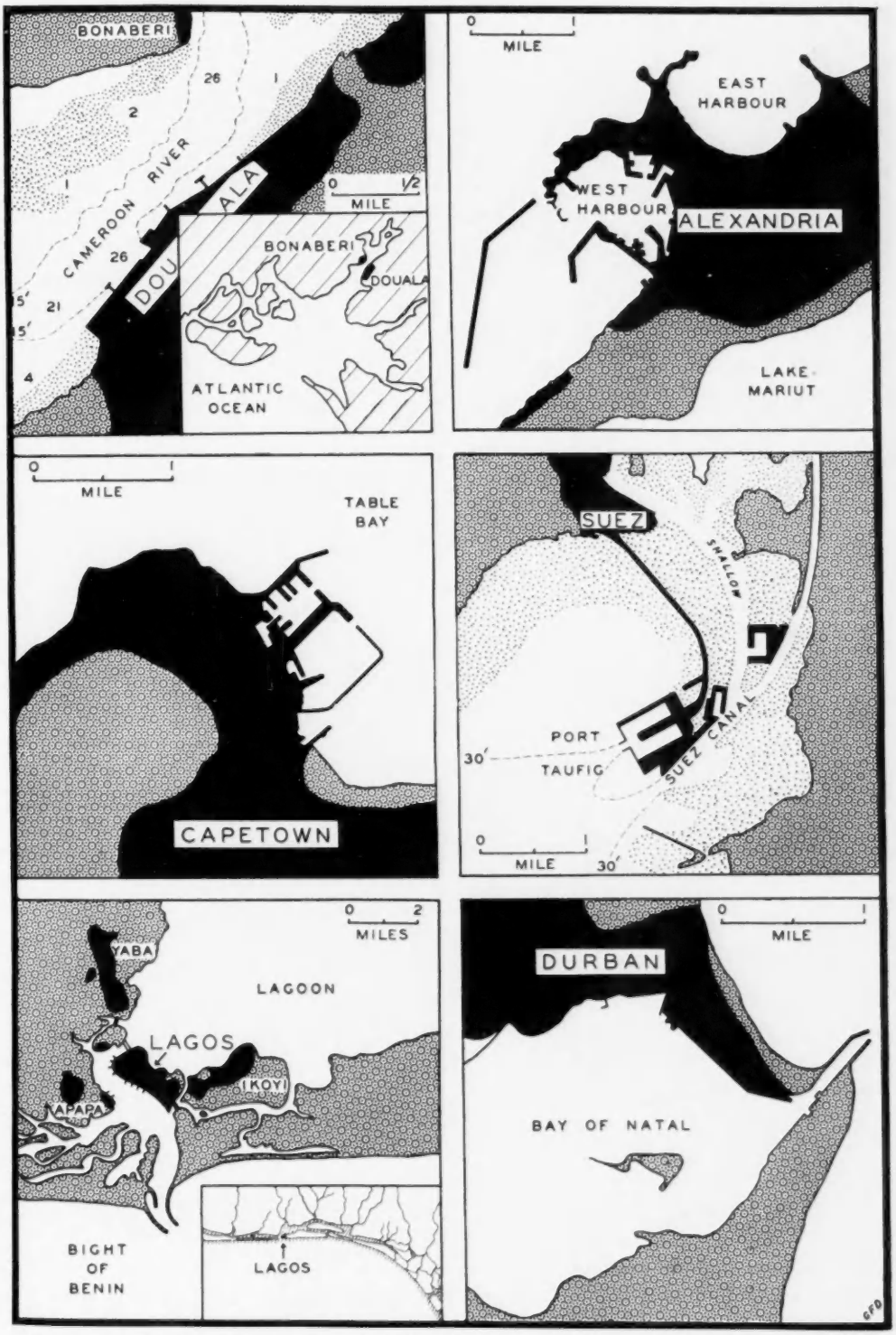


FIGURE 6.—Some British and French African harbors. Black represents built-up areas; heavy stippling indicates all other land; light stippling (Douala and Suez) is sand and mud flats; the unshaded part is water. All water depths are in feet. Note the differences in scale. A description of each harbor is contained in the text.

each a half-mile long, extend seaward from the entrance of the bay to help prevent silting of the channel. There is no need for projecting wharves within the bay; ships tie up broadside at the quay to load and unload. Harbor facilities are excellent and include much warehouse space, grain elevators, chilling rooms, efficient coaling apparatus, and South Africa's largest floating dock.

The small and nearly enclosed Lüderitz Bay of Southwest Africa is a diminutive but deeper version of Durban harbor; the formerly land-locked bays at Tunis and Bizerte are of a similar character, but they are larger and in one case (Tunis) shallower, in the other case (Bizerte) deeper.

Port Said (Figure 7), at the northern end of the Suez Canal, is built on one of the long, low sand bars which separate Lake Menzala from the Mediterranean Sea. Lacking protection and with shallow water extending offshore for a considerable distance (the three fathom line lies one to three miles offshore), it has been necessary to construct an entirely artificial harbor. Two long converging jetties project seaward from the bar, one on each side of the Canal entrance. A 30-foot channel has been dredged between the jetties to connect with the Canal. The harbor itself lies within the Canal, formerly on the west side only (Port Said) but more recently on the east side also (the new Port Fuad wharves). As at Port Taufig, the harbor area is small, but it is adequate since most ships stop only a short while to fulfill legal requirements and to take on provisions and fuel. Port equipment at both Port Said and Port Fuad is excellent, especially refueling and repair facilities. This harbor has no counterpart in Africa.

Mombasa (Figure 7) occupies the southeastern portion of Mombasa Island, which lies within one of the finest deep-water bays of Africa, formed by the drowned lower courses of several converging minor streams. The town itself is an ancient Portuguese port but it is located on shallow water and is little used by commerce today. Kilindini, on the southwestern side of the island, has the modern, sheltered, deep-water harbor. Depths of one hundred feet and more are found over a large area, and vessels drawing 33 feet can come alongside the up-to-date wharves. Shipping facilities are very good and direct rail connections tie both towns to the mainland and the interior.

Mombasa is typical of many of the deep, spacious, well-sheltered, drowned river bays of Mozambique, Tanganyika, and Kenya, including Mokambo Bay, Moçambique harbor, Porto Nakala, Memba Bay, Porto Amelia, Mikindani, Lindi, Kilwa, Manda Bay, et cetera. A counterpart is also found at Saldanha Bay, Union of South Africa.

The Portuguese port of *Lourenço Marques* (Figure 7) is built on the north bank of the submerged mouth of the English, or Espirito Santo, River at the point where it enters Delagoa Bay. This bay, about twenty miles broad at its maximum width, is sheltered to the east by Inyack Peninsula and Island but is open to the north. The true harbor, providing safe, all-weather anchorage, is the two mile wide English River estuary which is approached through the dredged Polana channel (low water depths of 25 feet). The harbor can be entered at any hour of the day or night without the help of tugs, and independently of the tides. A mile-long concrete wharf, with depths of 28 feet and more alongside, can accommodate twelve to fifteen large steamers at one time and is provided with warehouses, railway lines, cranes (thirty-eight in all), coal-hoists, and pre-cooling chambers (Figure 12). Lou-

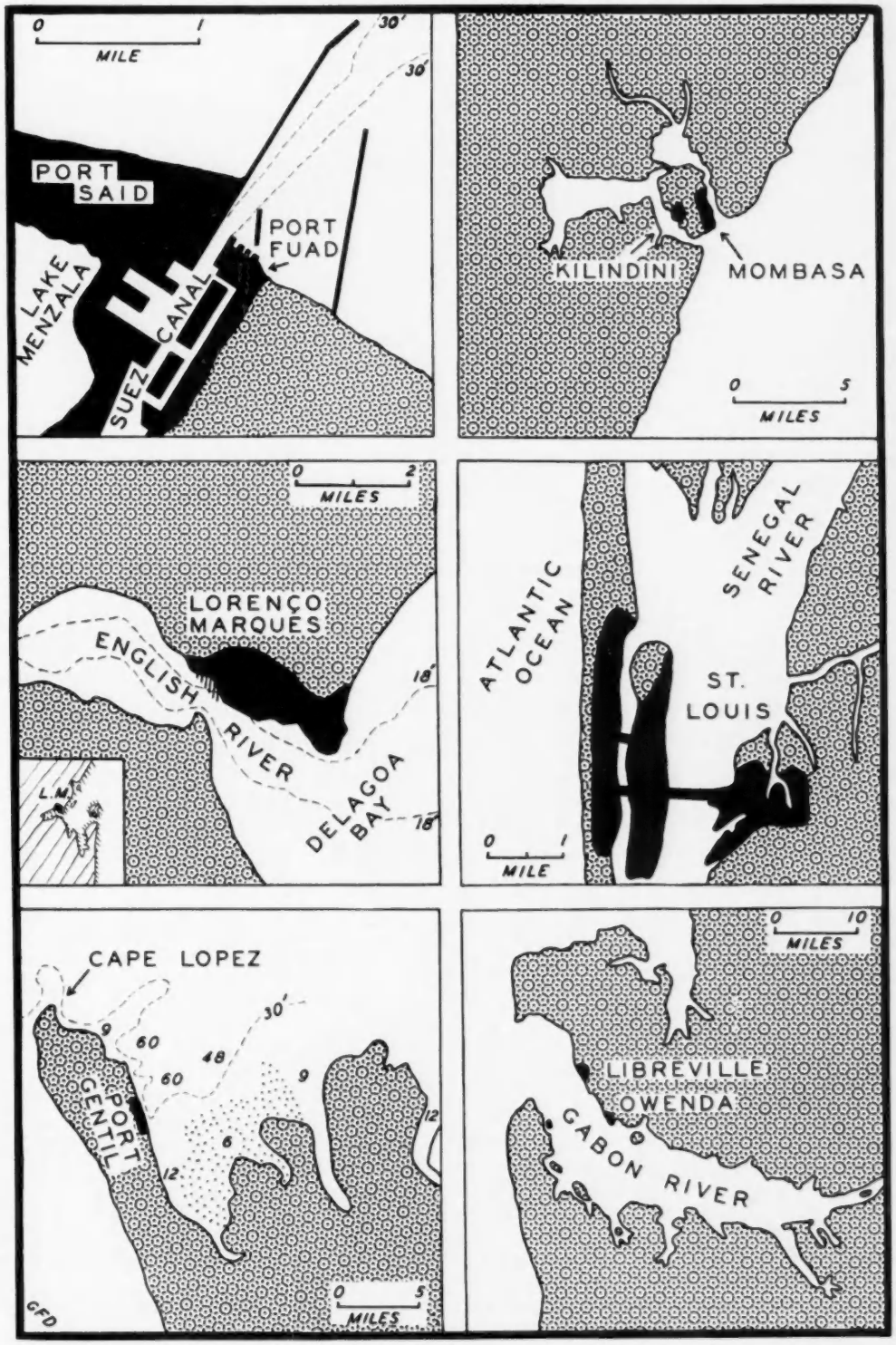


FIGURE 7.—Additional African harbors. Black represents built-up areas; heavy stippling indicates all other land; light stippling (Port Gentil) is sand and mud flats; the unshaded part is water. All water depths are in feet. Note the differences in scale. A description of each harbor is contained in the text.

rençco Marques resembles Mombasa and the many similar East-Central African harbors in the general character of its harbor.

Saint Louis (Figure 7) is situated at the mouth of the Senegal River, on a long, narrow offshore bar (the "Langue de Barbarie"), the adjacent mainland, and an intermediate island. The port has no harbor. Because of the shallow waters offshore from the bar, ocean vessels must anchor in the open roadstead a considerable distance from the coast. All goods are conveyed to and from shore by small surf-boats under extremely difficult, costly, and dangerous conditions. (To illustrate the handicaps to trade associated with such conditions, the *Gold Coast Annual Report for 1926* states that when five or six ships are anchored off Sekondi, a similar type of open roadstead port, the average amount of produce loaded on a vessel is only 180 tons per day.)

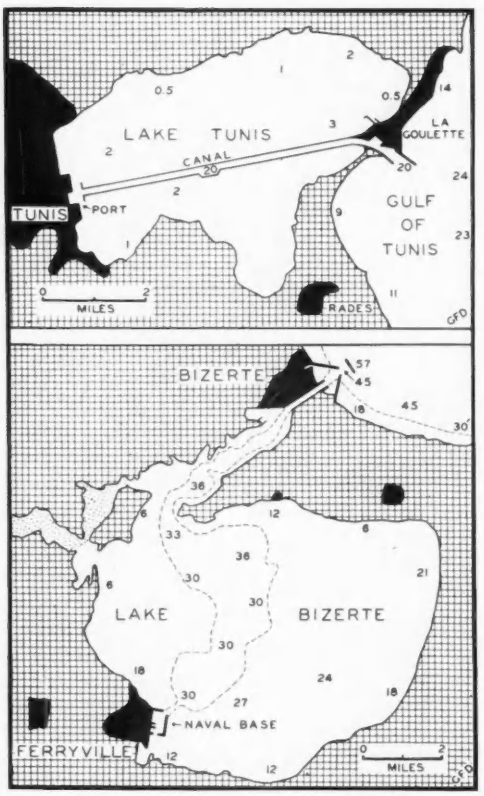


FIGURE 8.—Harbors of Tunis and Bizerte. Black represents built-up areas; cross-ruling indicates all other land; light stippling is sand and mud flats; the unshaded part is water. All water depths are in feet. Note the differences in scale. A description of both harbors is contained in the text.

Saint Louis is typical of the numerous surf-bound ports of the bar- and lagoon-fringed shore of Africa between western Liberia and the Niger delta, including Grand Lahou, Grand Bassam, Petit Bassam, and Assinie on the Ivory Coast, Accra, Sekondi, Salt Pond, Winneba, and Cape Coast on the Gold Coast, and Lomé, Grand-Popo, Porto-Novo, and Cotonou in Togoland and Dahomey. There are literally dozens of ports of less significance but with similar characteristics in the same area, and along the coast of much of French Equatorial Africa. Occasionally, short wharves have been built seaward and shallow draft tugs and lighters are substituted for native surf-boats (for example, at Sekondi, Cotonou, Accra, and Lomé), but these are only half-way measures for overcoming the inherent handicaps of the coast. In the case of Takoradi, on the Gold Coast, a completely artificial harbor has been dredged between breakwaters extending offshore from the coast. (Two granite-block breakwaters shelter a basin in which an area of several hundred acres is available for anchorage. Low-water depths alongside the docks are over 25 feet.) At Lagos (discussed above), a harbor has been constructed behind the bar at a place where depths were particularly favorable for such a venture, and the French are reported to be constructing a similar harbor at Abidjan, on the Ivory Coast, where natural conditions are likewise very favorable. (See discussion that follows.) In general, however, the bar-fringed shores retain their open roadstead ports.

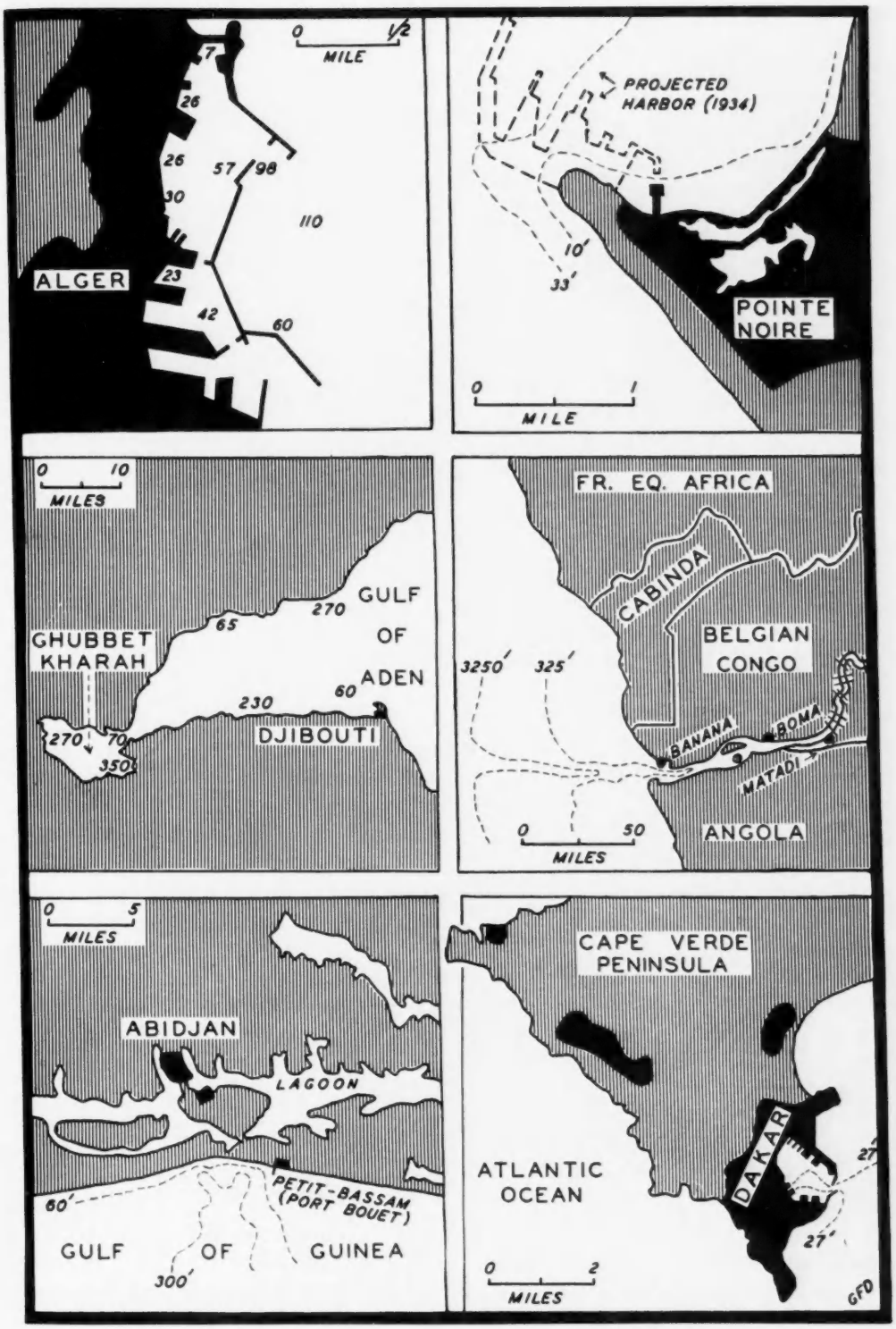


FIGURE 9.—Some French and Belgian African harbors. Black represents built-up areas; close ruling indicates all other land; the unshaded part is water. All water depths are in feet. Note the differences in scale. A description of each harbor is contained in the text.

FIGURE 10.—Air-view of the western part of Alexandria harbor, looking toward the southeast. The former island of Pharos is in the foreground, the mainland is in the middle distance, and the artificial connecting isthmus is to the left. This picture was taken while the harbor was under fire from German planes. (International News Photos.)

Port Gentil (French Equatorial Africa), another open roadstead, lies on the inner, partly sheltered edge of a long, broad sand-spit forming the western side of Lopez Bay, at one of the few places on the west-central African coast where deep water approaches the shore (Figure 7). The port is protected from east, south, and west winds, but is open to the north and northeast. It represents, therefore, an intermediate condition between the exposed location and shallow water of Saint Louis roadstead, and the completely protected, deep water sites of harbors like Lourenço Marques and Mombasa. Vessels anchor one-half to one mile from shore and discharge into lighters. Port facilities are poor.

Numerous ports of Africa have deep water, semi-protected positions similar to that of Port Gentil. Saint Helena Bay, eighty miles north of Capetown, is one example; Lurio and Almeida Bays, in Mozambique, are others. Table Bay and Algoa Bay, Union of South Africa, were similar semi-protected embayments before the artificial harbors of Capetown and Port Elizabeth were constructed.

Libreville and Owenda (Figure 7), on the Gabon River estuary, furnish another example (like previously mentioned Douala) of a drowned river providing an excellent harbor site. The sheltered estuary, five to ten miles wide, extends inland more than forty miles and in general is more than 30 feet deep. (Near the mouth, there are depths of 170 feet.) While it is necessary for vessels to anchor about a mile from shore and discharge into lighters at Libreville, 30 feet of water exists less than 300 feet from shore at Owenda. Facilities are poor at both ports, but Owenda could be fitted up as a first-class harbor and port at no great expense.

Tunis (Figure 8) lies at the head of the open Gulf of Tunis, on the inner margin of a broad but very shallow lagoon (Lake Tunis) through which a narrow channel, six miles long and 20 feet deep, has been excavated. The former unprotected port of La Goulette, at the entrance to the lagoon, has become a fishing center. Most of the modern

terminal facilities line the Tunis waterfront, although some equipment is available at La Goulette.

With its *very* shallow, channeled embayment, Tunis is unique among African harbors. It has been classified here as an artificial harbor, because it is so completely man-made.

In order to understand the harbor at *Bizerte* (Figure 8), it is necessary to know something of the physical situation in the adjacent region. Like the several other lakes that line the Tunisian coast, including Lake Tunis, Lake Bizerte is an ancient depression that has been invaded by the sea. Unlike the others, however, it is bordered on its inland margin by a large marsh, the Garaa Achkel, through which many of the tributary streams first flow. There they deposit much of their alluvial load, and the water that enters the lake itself is largely free of sediment. Depths exceeding 35 feet have thus been maintained over an area of many square miles in Lake Bizerte, permitting it to accommodate an unlimited number of the largest vessels. This fact, combined with its perfect shelter, has made it the finest natural harbor on the entire North African coast. The French have established at Ferryville, near the head of the lake, one of the best equipped naval bases in the world.

Among the other African harbors, Bizerte resembles most closely the almost land-locked embayments of Durban and Tunis. Its distinctive feature, however, is its great depth.

The port of *Alger* (Figure 9) is located on the broad, open Bay of Algers. The structure of the bay is typical of all the open, northward-facing, sickle-shaped bays that indent the Algerian coast. The two "horns" of the bay are of old, hard, pre-Cambrian schists. The intervening coast is of weak Tertiary rocks at whose expense the bay has been cut out by wave erosion. Such a bay is entirely different in origin and character from the drowned river estuaries that form so many of the harbors of other

FIGURE 11.—Air-view of the artificial harbor of Capetown, in open Table Bay. View looking toward the southeast. (World Wide Photos.)

parts of Africa. Like almost all Algerian ports, Alger is located on the western side of the bay, since such a position offers shelter against the strong storm winds from the northwest.

The Phoenician, Roman, and Berber port comprised merely the narrow, partly-sheltered waters between the mainland and several small islets lying a short distance offshore. During the sixteenth century, one of the islets was connected to the mainland by a jetty and for three centuries the small port was used as a place of refuge for the ships of the Barbary pirates. (The Arabian name for this port, "El Djezaïr," meaning "The Islets," has been Romanized into Alger.) Today, the harbor of Alger extends from the Ilot de la Marine in the north, which is attached to the mainland by a causeway, southward along the shore of the bay for a distance of more than two miles. The harbor is divided into three basins, the "Port de Commerce" in the north, a mile long and one-half mile wide, the "Port de L'Agha" in the center, approximately one-half mile square, and the "Bassin de Mustapha" in the south, also about one-half mile square. Complete protection is provided by an elaborate system of breakwaters and piers. Depths of from 20 to over 30 feet exist alongside the wharves of all three basins so that large vessels can be accommodated. Port equipment is of the best.

Alger is typical of most of the artificial harbors that line the shores of French and Spanish North Africa, from Casablanca in Morocco, through Ceuta, Melilla, Oran, Bougie, Djidjelli, Philippeville, Bône, and Sousse, to Sfax in eastern Tunisia. The artificial Italian harbors of Tripoli and Bengasi in Libya are also closely parallel in character. Some of these harbors are smaller (only one or two basins), more shallow, and have less elaborate port facilities than Alger (Casablanca and Sousse, for instance), but others are almost as large and deep and are just as well equipped (Oran). They all present the same general appearance, however.

Pointe Noire (Figure 9), in southernmost French Equatorial Africa, occupies the southern rim of a small, unprotected embayment. Important harbor works, begun in 1931, are now completed. Information is difficult to obtain concerning this new harbor, but if the plans contemplated as late as 1934 have been followed, the configuration and depths will be approximately those shown in the drawing. The reinforced concrete breakwater probably extends northward and eastward beyond that indicated in the drawing, to enclose an area of several square miles of sheltered water. Additional deepening of the shallow water sections along the inner portion of the wharves has also undoubtedly been accomplished. Port equipment is probably excellent. Pointe Noire, therefore, should now be one of the best artificial harbors on the West African coast.

The bay of *Ghubbet Karah* (Figure 9) is the largest and deepest sheltered indentation of Africa, with a width of from five to thirteen miles and a depth of hundreds of feet over most of its extent. It is presumably a drowned structural depression, probably associated with the great Rift Valleys of East Africa. The entrance into the bay from adjacent Tajura Bay, an arm of the Gulf of Aden, is somewhat encumbered in places with shoals and strong currents, but it can be navigated by the largest vessels. Several good anchorages exist close inshore within the bay, but none is used at present. Ghubbet Karah is an example of the many excellent but undeveloped African harbors.

Three major ports line the lower Congo River, Banana, at the mouth of the stream, and *Boma* and *Matadi*, some fifty-four and eighty-three miles upstream respectively (Figure 9). The first is unprotected and has no harbor; the latter two, however, afford excellent shelter. Depths along the lower Congo, up to the falls immediately above Matadi, are adequate for the largest vessels. At Matadi, the channel is more than 200 feet deep in places; farther downstream, at Boma, the average depth is 50 to 100 feet. From a point some thirty miles above Banana, there is a broad channel with more than 300 feet of water, and at Banana itself there are channel depths in excess of 1,300 feet. In addition, there is no bar at the mouth of the Congo since the sweep of the current is sufficient to carry the alluvium out to sea. (The current is occasionally so strong that it actually constitutes a hazard to shipping. Although Boma is always accessible, vessels are sometimes unable to reach Matadi during high water, when the current is often 5 knots an hour and a flow as great as 10 knots has been reported.) The river channel in turn is continued in the open ocean by a narrow submarine channel with depths of several thousand feet.

Boma and Matadi both have rather well-equipped ports. There is one wharf, 800 feet long, at Boma, and two wharves with berths for eight steamers at Matadi (Figure 13). Ships drawing 23 feet of water may anchor alongside these wharves, and with a small amount of dredging or the extension of their piers channelward, ships of any size could be accommodated.

Abidjan and its port, *Petit Bassam* (Port Bouet), are situated respectively on the mainland and the adjacent bar

FIGURE 12.—Air-view of the port of Lourenco Marques in Mozambique, at the mouth of the English River, looking toward the southeast. Note the elaborate harbor facilities. (Photo by Mary Light, in "Focus on Africa," published by the American Geographical Society of New York.)

FIGURE 13.—Port of Matadi, Belgian Congo. This deep-water port is eighty-three miles upstream from the mouth of the Congo River. (Belgian Information Service.)

of the middle Ivory Coast, and are connected by a floating bridge across the lagoon (Figure 9). Abidjan itself is not a seaport but rather an entrepôt for the inland traffic that uses the sheltered waters between the bar and the mainland. The present port of Petit Bassam, like many of the Guinea Coast ports, has an unsheltered roadstead where lightering is necessary. However, possibilities for the development of a major harbor are much better than at most of the other ports. A deep submarine channel, the "Trou Sans Fond" (the ancient submerged valley of the Comoé River), represents one of the few places along the northern coast of the Gulf of Guinea where deep water is present close to shore. Depths of over 30 feet and even 60 feet exist only a very short distance offshore, a little to the west of Petit Bassam. Likewise, the lagoon behind the bar and immediately south of Abidjan is unusually deep. A first attempt to develop these possibilities was made in 1903 when a deep water canal was begun across the bar, directly south of Abidjan. The expense proved to be too great at that time, but plans have been made to complete the project in the near future, and the French are reputedly pushing construction because of its strategic value during the present war. When completed, Abidjan will be a second Lagos.

The last of the individual harbors of Africa to be discussed is *Dakar* (Figure 9). Situated at the southern end of Cape Verde peninsula, the port originally had only the partial protection of the peninsula to the north and west. The present improved port boasts one of the finest artificial harbors on the west coast of Africa. Complete protection is provided by two long breakwaters, and the dredged channel between admits ships drawing more than 27 feet of water to certain of the docks. Railroads, warehouses, storage yards, and cranes line the quays. There is a large dry dock, and excellent repairing and refueling facilities are available. Dakar closely resembles Capetown in its semi-protected location in an open bay.

CONCLUSION

Present and potential military operations in Africa have focused attention upon its ports and harbors. Post-war development of the tremendous resources of the continent is certain to occur, and the expanded trade which follows will further increase the world significance of these harbors. An overview of their number, distribution, and character, therefore, should prove of value in enabling one more correctly to appraise some of the events that are happening today and to predict certain trends in the future development of the continent.

Note: Some of the maps and data included in this article may be somewhat incomplete or out-of-date. It is an unfortunate but unavoidable difficulty with such a subject, especially in times like these while a world war is being waged. In the main, however, it is believed that the information is reliable and, together with the maps, sufficiently complete to furnish the reader with a good general impression of the harbor facilities of Africa.

AGRICULTURAL REGIONS OF AFRICA

PART III. PRESENT AND POTENTIAL PRODUCTIVITY OF THE LAND (*Continued*)

H. L. Shantz

AFRICA is a plateau (Figure 239) and most of the area is comparatively young but rests upon an archaic block. In the eastern highlands, recent igneous materials have been superimposed. The plateau is high in the south and east and folded mountains occupy the extreme northern part.

Topography

The whole continent averages about 2,000 feet elevation and most of the land lies between 1,000 and 5,000 feet. A great area of land mostly above 2,000 feet extends across from Ethiopia to the Cape and west to include much of Angola. Another strip lower and more interrupted extends along a line from Madagascar across to Morocco. Highlands are also found in French Guinea and the Cameroons.

The southern plateau breaks off sharply in the west and east and in the south drops from the Karroid Plateau in a series of steps to the Great Karroo, to the Little Karroo, and to the coastal plain. This plateau gradually slopes to the north where at about six degrees south it falls to the 2,000-foot contour.

The East African highland with extended areas above 10,000 feet is famous because of the Rift Valley system formed by a block between two rock fractures falling in to form a ditch or "Graben." These are easily distinguished and run in a general north and south direction. The western rift, regarded as the youngest (Pleistocene), is marked by the Lakes Nyasa, Tanganyika, and Albert and leads on north to the Nile at Gondokoro.

The middle rift runs north-northeast from Lake Nyasa, through Lakes Manyara, Natron, Navasha, and Rudolf and on to the Red Sea and Gulf of Aden. The eastern rift runs northeast from about the middle of Lake Nyasa. The depth of these valleys is very great. The water level of Lake Nyasa is about 1,555 feet above sea level and the lake is about 2,316 feet deep, the bottom being about 760 feet below sea level. Great volcanic mountains rise mostly east of the middle Rift Valley where Kenya rises to 17,040 feet and Kilimandjaro 19,720 feet, and east of the west rift where Rewinzori rises to 16,794 feet.

The Somali highland is a block of land broken off sharply on the north to the Gulf of Aden, less sharply to the southeast to the Indian Ocean. The Ethiopian highland is a block between 5,000 and 10,000 feet in elevation and rises to an extreme of 15,100 feet. It is bounded both on the west and east by great fractures. This block is deeply dissected. A rift leads from the Gulf of Aden and the Red Sea through Awash and on south to Lake Rudolf.

A number of great basins characterize this continent. Several of these are interior basins and comprise a large part of the land area (Figure 120). Chief of these are the large areas in the Sahara where rainfall is not sufficient to supply more water than is easily evapo-

rated. The Chad basin receives a liberal supply from the rivers entering from the south and a great marshland is the result. Another basin only partially land locked is the Ngamiland area in South Africa. Here also a marsh grass area is developed. The middle Rift Valley is an inland drainage basin including Lakes Rudolf, Navasha, Natron, and Manyara. The southern basin on the south African highland is drained by the Orange River which rises in the Drackenbergs on the eastern edge of the plateau and crosses the desert lands to break through the western edge and empty into the Atlantic Ocean. Far north of this basin the Zambesi cuts through to the east to drain

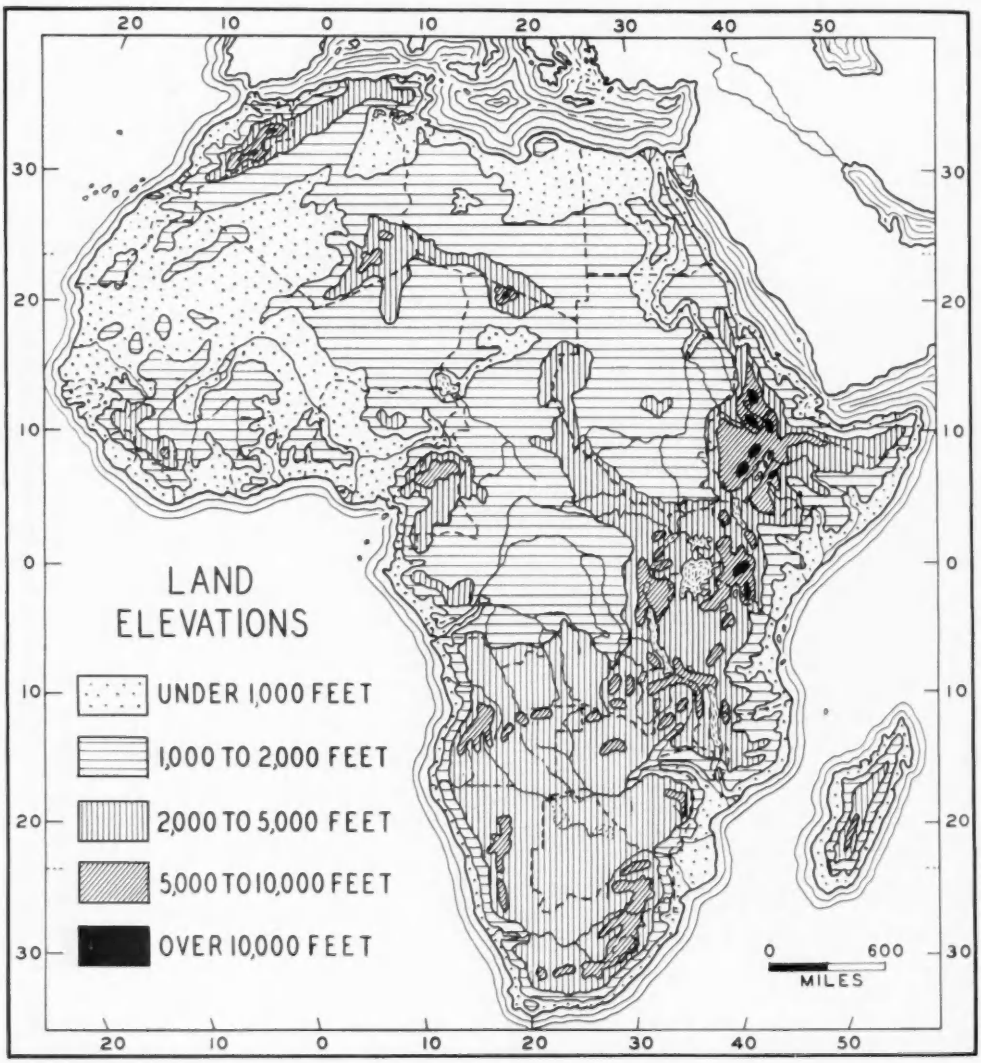


FIGURE 239.—Land elevations are shown as follows: 1. Elevations from sea level to 1,000 feet. These areas except in the north and west lie near the coast. 2. Areas from 1,000 to 2,000 feet. These areas also lie for the most part north and west. 3. Areas between 2,000 and 5,000 feet are mostly in the east and south. 4. Areas between 5,000 and 10,000 feet are on the east and south African highlands with areas in the Atlas, Cameroons, Angola, and southwest Africa. 5. Areas above 10,000 feet lie mostly in Ethiopia, the central African highland, the south African highland in Basutoland, and the Atlas in Morocco.

a great basin including much of northern Rhodesia and Angola.

The Congo basin at an elevation of over 1,000 feet, surrounded by land of 1,500 feet elevation or more, is drained by the Congo River with many great tributaries, chief among which are the Ubangi in the north, the Kassai in the south, and the Lualaba in the southeast. It is about 3,000 miles long and drains nearly a million and a half square miles. The Nile is over 4,000 miles long if it is regarded as having its source in the Kagera River. It drains much of the east African highlands, Lake Victoria, the great marshland of the Bar El Gazal and receives the waters of the Ethiopian highlands through the Sobat, Blue Nile, and Atbara. A great amount of the water

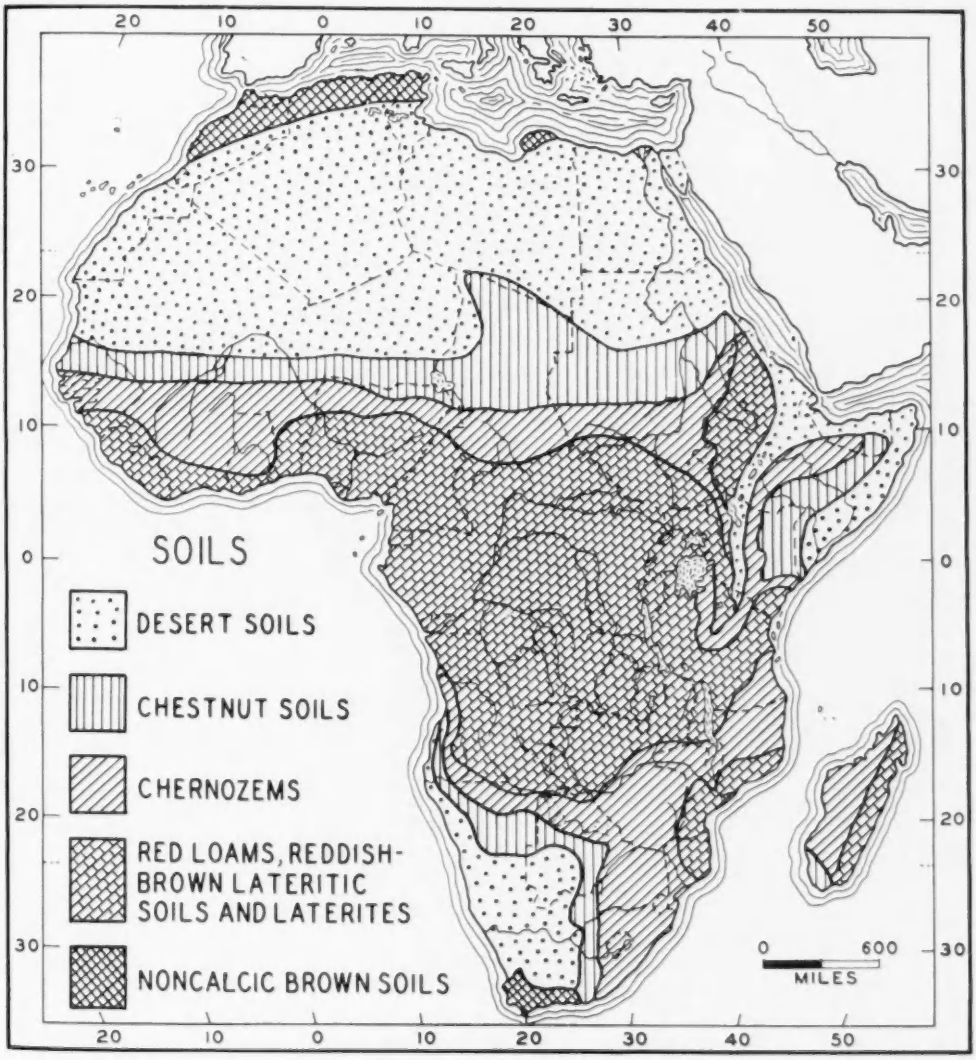


FIGURE 240.—A generalized soil map of Africa mostly from Marbut's soil map (in Shantz, H. L., and Marbut, C. F., "Vegetation and Soils of Africa." American Geographical Society, *Research Series No. 13*, New York, 1923). The divisions here shown are: (1) Desert soils; (2) Chestnut soils; (3) Chernozems; (4) Red loams, Reddish-brown Lateritic soils, and Laterites; and (5) Noncalcic Brown soils. (See Marbut's map and discussion for further detail.)

coming from the south which reaches an average of 75 million cubic meters daily at Mongalla shrinks to 27 million cubic meters below Lake No, where the Sobat adds 38 million, the Blue Nile adds 141 million, and the Atbara 33 million. This total of 239 million cubic meters shrinks to 226 at Aswan. This is the water which enables Egypt to stand first in all Africa as a producer of agricultural products. In April and May the White Nile produces 85 per cent and the Blue Nile 15 per cent of the total for these two rivers. In June the Blue Nile floods to 15 times as much water as the White Nile and dams back the White Nile at Khartoum, a distance of 280 miles. The fall of the White Nile is only 0.6 inches per mile at this place.

The Niger rises at about 1,500 feet near the Guinea coast and flows northeast to the desert, then southeast and south to the Gulf of Guinea after traversing a distance of about 2,600 miles.

The influence of topography. The influence of the great southern plateau shows clearly on the distribution of natural vegetation and upon the agricultural potentialities. The highlands of the Transvaal and Orange Free State are decidedly temperate in the character of their produce while farther south in Natal and Cape Province sub-tropical conditions prevail. Likewise farther north in the low veldt of the Transvaal and in southern Rhodesia conditions are such that characteristically temperate zone crops can be grown in winter which are produced on the high veldt only in summer.

Frosts may occur in the high plateau any month in the year but are usually absent except during April to October. In other words, November to March is usually frost-free. The coastal region is relatively frost-free and snow rarely falls. Even in the Transvaal snow has fallen only eleven times in fifty-seven years.

The agricultural significance of the topography is evident in modifying the production in south Africa and by carrying cool-weather crop production and European cattle raising north into the tropical zone. It is also evident in East Africa near the equator where a cool weather area with no frost favors the production of almost any cool-weather agricultural crop. The North East African highland supplies the Nile Valley with an abundant and continuous water supply. In addition there are many sections both south and north of the equator at between 15 and 35 degrees where warm-weather crops can be grown during the summer months and cool-weather crops during the winter months. As an example, at the region of Salisbury of Southern Rhodesia at about 18 degrees south the following crops are produced: as summer crops (October to March), maize, sorghum, pumpkins, citrullus, sweet potatoes, ground nuts, beans, cow peas, cotton, tobacco, sunflowers, and hemp; and as winter crops (April to September), wheat, oats, barley, and potatoes.

In other words, south Africa and north Africa have for the most part a continuous productive season which during summer produces short-lived warm-weather annual crops and during winter produces short-lived cool-weather annual crops. The same climate produces both deciduous and citrus fruits. However, it does shut out such crops as banana and coffee which suffer from low temperatures and of which important varieties thrive at a temperature suitable to such crops as wheat, oats, flax, and barley on the high plateaus of central Africa. Except for the high elevation in Southern Rhodesia and continuing north to Ethiopia, the cool-

weather crops could not be grown in this area.

Near the equator there is little change in temperature from month to month and crops can grow continuously throughout the year in the regions with adequate rainfall. In the lowlands warm-weather crops such as oil palm, banana, and manioc grow continuously and crop after crop of maize or rice are produced. In other words, there is no rest period caused by drought or by cold, and the land is continuously productive of warm-weather crops.

Likewise in the highlands of central Africa almost any temperate zone or cool-weather crop can be grown continuously and there is no drought or cold

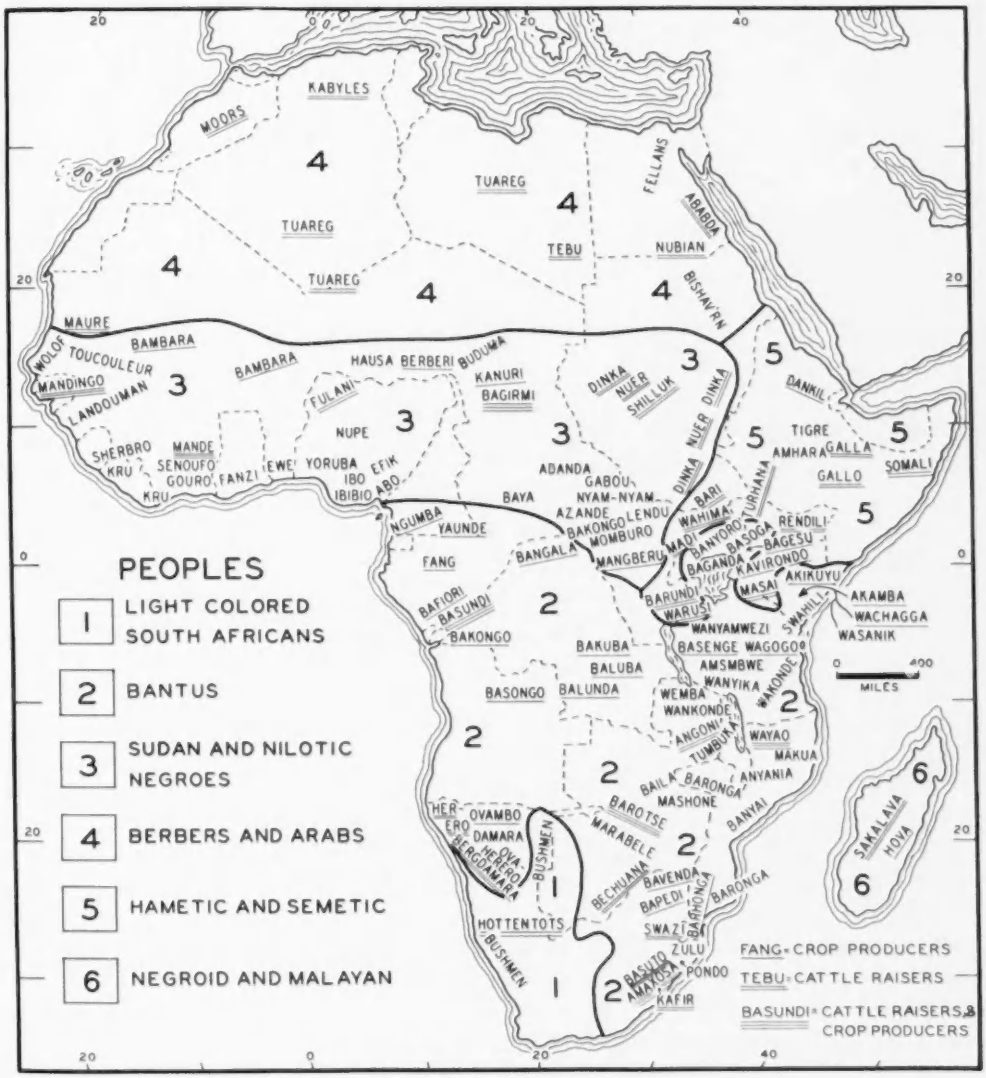


FIGURE 241.—Peoples of Africa. The divisions and boundary lines are mostly from Smidt, Max, "The Primitive Races of Mankind," translated by A. K. Dallas, London, 1926; and the names of tribes mostly from Frazer, Sir James George, "The Native Races of Africa and Madagascar," London, 1938. The main divisions are: 1. Light-colored south Africans. 2. Bantu peoples. 3. Sudan and Nilotic Negroes. 4. Berbers and Arabs. 5. Hamitic and Semitic peoples. 6. Negroid and Malayan peoples.

rest period and the land is continuously productive of cool-weather crops since temperatures are never high enough to interfere with their normal physiological development. Even slight elevations such as those in French Guinea and Angola greatly increase the variety and often the value of the crops to be grown. These elevations are usually accompanied with increase in rainfall.

With cattle an equally direct correlation with climate as influenced by elevation is evident. The recent work in south Africa (Bonsma, J. C., The Influence of Climatological Factors on Cattle: Farming in South Africa, Oct. 1940), has shown that taurine beef and dairy breeds of Europe and America cannot function normally at higher temperatures. The effect is to cause a fever by the inadequate control of body temperature which burns out the reserve food supplies of the body, thus making it impossible for them to produce either meat or milk. This limits cattle production in the lower and warmer portions of the continent to breeds derived from *Bos indicus* and shuts out European breeds derived from *Bos taurus*.

FIGURE 242.—A Bushman, showing the characteristic yellow wrinkled skin and tightly curled bushy hair. Prieska, Cape Province.

Body temperatures of European breeds in the low veldt at Messina often rise to 106 or 107 degrees F. at 85 degrees F. air temperature, when it should be about 101 degrees at 65 degrees F., and the rate of respiration to 60 or 70 at 85 degrees F., when it should be about 20 at 65 degrees F. Under these same conditions Afrikander cattle show almost normal respiration rate and body temperature. It is evident, therefore, that the races developed in cool European climates cannot succeed under these near-tropical conditions. The high elevations even in central Africa produce conditions under which European breeds can be reared. Still the great number are of the Zebu types, showing either the hunch or the large horns or both.

SOILS

The soils of Africa have been studied only in a comparatively few places and the results are still not fully correlated. Only the broad primary groups can be shown here. These are taken from several sources which in turn have been taken largely from Marbut (Shantz, H. L. and C. F. Marbut, The Vegetation and Soils of Africa. American Geographical Society, Research Series No. 13, New York, 1923).

In Figure 240 the 16 groups shown by Marbut are condensed to five; (1) light colored desert soils, (2) chestnut soils, (3) chernozems, (4) red loams, the reddish brown lateritic soils, and the laterite soils, and (5) noncalcic brown soils.

The first three are pedocals. These soils are unleached since the rainfall is insufficient to penetrate below the reach of the grass roots and all water is reabsorbed and delivered back into the air either by evaporation or transpiration. The lime carbonate may be found on the surface and distributed throughout the soil profile in the desert soils or carried down to form a zone

at the bottom of the soil profile in the chernozems. The noncalcic brown soils, the red loams, the reddish brown lateritic soils, and the laterite soils are pedalfers since water leaches through them, carrying off soluble mineral materials and also in the last two hydrolyzing much of the iron and alumina.

These groupings correspond to physical conditions of climate and soil moisture and are correlated closely with the natural vegetation.

Of the five divisions here considered the light desert soils have been least studied and show the least differentiation. In fact in many cases they represent the fine materials left in place or moved about by wind action. Great dune areas are found in the deserts. Often these dunes are moving constantly, dependent upon the wind currents.

Where soil materials contain a mixture of fine material and pebbles or coarse gravel too large to blow away, the fine material is blown out and the pebbles concentrate on the surface until they form a close "desert pave" with the upper or exposed faces of the pebbles eroded and polished to show the "desert varnish." As long as any soil particles can be moved by wind, this concentration of pebbles at the surface continues until a perfect cover is secured. Beneath this accumulation of gravel or pebbles the soil may contain only an occasional pebble. The amount of the lowering of the soil surface which was necessary to accumulate enough pebble material fully to cover the surface can easily be computed. Except for this pebble cover there is no profile developed.

Where more soil moisture is available and when water passes down through the soils to be reabsorbed by desert plants there may be a profile developed.

Desert soils are light colored, varying from light grey to browns and reds, the color being largely determined by the parent material. They are usually calcareous in both surface soils and subsoils. They vary from sands and gravels to finer materials. Because of lack of water, the clay forming minerals have not yet been broken down. Under irrigation they increase in water holding capacity and become heavier. Where rainfall is sufficient to form a vegetation cover, they show a definite profile, are usually rich in mineral matter and lime

FIGURE 243.—A hottentot woman and her temporary home, consisting of the wagon, a brush protection hedge, and simple cooking utensils. Prieska, Cape Province.

to the very surface, but low in nitrates. In the bottoms of interior drainage basins these are likely to be saline.

The chestnut soils include the chestnut soils and the reddish chestnut soils of the desert edge.

In these soils the lime is usually present even at the surface of the soil. These soils have usually a fairly good plant cover of shrubs and grasses. The grass cover is not so even and the soils moisture does not so evenly penetrate as in the chernozems. In most cases plants are shallow rooted because of the fact that only the surface soils are moistened by rainfall and the water is absorbed by the roots and returned to the air. This moistened portion of the soil profile is much shallower than in the chernozems, and the lime car-

FIGURE 244.—The Bantu. The Bechuanas are cattlemen. Here a young boy of the Bakgatla tribe is modeling large-horned humped-back cattle in wet clay. Some of them are tied with bast fiber strings and some are placed in kraals made of sand. Mochudi, Bechuanaland.

bonates do not produce so definite a layer as is found in the chernozems.

The chernozems. This term used originally for black soils with a distinct line of carbonate accumulation at the lower part of the soil section has been extended to include the dark brown or even red or pink soils in warmer climates which still show the zone of carbonate accumulation. The typical chernozems develop where rainfall is not sufficient to provide soil water enough to penetrate to the deeper soils and the subsoils are permanently dry. The black phase also occurs where poor drainage has prevented the loss of carbonates. Little is known of the distribution of these soils in Africa. Milne (Milne, G., A Provisional Soil Map of East Africa. Amani Moirs, 1936) studied the soils of east Africa and classified as plains soils and as black or grey clays the soils which would fall into this group. He did not broaden the Russian term Chernozem to include these soils. Still they have a dark color and usually a zone of carbonate accumulation. Chernozems differ from the chestnut soils in having a darker and better developed top soil and in supporting a denser grass cover. They are usually especially productive.

The brown soils of the Cape and Atlas region are as a rule leached and show no accumulated carbonates. The cool moist winters and dry hot summers present conditions which favor leaching of soil but a rather restricted plant growth. Surface soils are brown, reddish brown, or red and the subsoils inclined to be heavy. Conditions are such that with irrigation or careful culture sub-tropical fruits and vegetables and grains can be produced. The grains are grown as winter or semi-winter crops. Therefore, the production of the land is nearly a continuous process throughout the year. In general these soils are similar to those west of the mountains in California.

The red loams, the reddish brown lateritic soils, and the laterite soils are more extensive in Africa than are any other groups. They vary from young soils through deep red well drained soils to laterized soils. In the latter, Martin and Doyne (Martin, F. J. and H. C. Doyne. Soil Survey of Sierra Leone, Dept. Agric. Sierra Leone. 1931) have used the ratio of silica to alumina to define lateritic (laterized) soils as those in which there is from 1.33 to 2 parts of silica to one part of alumina, and as laterite soils those in which there are less than 1.33 parts of silica to one of alumina. Milne in east Africa has followed this formula. Naturally, these soils do not uniformly cover the areas and there is a great amount of overlapping and mixing. The soils are developed in warm and damp climates. They cover the greater part of tropical Africa. In places where hydration has been extreme due to high temperatures and high humidity and where most of the soluble portion of the parent material has been leached out and the concretions become cemented together, an almost impervious pan of laterite is formed. The growth of plants in such

a place is usually limited to grasses and dwarf shrubs. Forests, savanna, and a rank growth of brush and grass are found on the red loams and on the lateritic soils. These are comparatively rich soils found in much of east Africa and throughout central Africa. In Sierra Leone, Martin and Doyne summarize soils conditions by saying that practically all soils are light and easily penetrable by water, except of course the swamp soils, that all are more or less acid (p H 4–6), and that they are either laterites or lateritic, that they are poor in exchangeable calcium and in nitrogen, phosphorus, and potash. The native system of agriculture allows the land to grow up naturally to brush for from eight to ten years. This increases the plant food which is increased by the ashes and organic matter returned to the soil when the land is again cleared. Under European methods of cultivation mineral fertilizers would probably yield big returns.

It should be borne in mind that in all of these areas great acreages of alluvial land and swamp land offer more fertile soils for crop production than those characteristic of the area as a whole.

NATIVE PEOPLES OF AFRICA

European influence is great in North Africa and in South Africa. The central colonies seldom have as many as one European to 100 natives (Figure 89) and the pattern of native occupancy has not been greatly changed by European domination.

The African natives have been grouped (Schmidt, Max, The Primitive Races of Mankind. Translated by A. K. Dallas, London, 1926, page 287) as follows:

"(1) The comparatively light-skinned inhabitants of South Africa and the Pygmies of Central Africa.

"(2) The Bantu, who, with the above, occupy the southern half of Africa—up to the equator.

"(3) The Sudan Negroes from the equator to the southern border of the Sahara.

"(4) The light-skinned Berber, in the Sahara and along the north edge of Africa, including the Nile region."

FIGURE 245.—A Bantu woman of the Kukuyu group and Chuca tribe. The heavy load of sugar cane is being carried home on her back by the use of a head band which she has temporarily removed. The dress consists of a beaded skirt, bead strings, and arm and ear ornaments. North of Embu, Kenya Colony.

In northeast Africa the Hamitic and Semitic influence is strong and this area has been shown as division 5 in Figure 241; Madagascar is shown as division 6. Authors differ considerably in grouping the races of African peoples. (See also Deniker, J., *Les races et les peuples de la tierre*, Paris, 1926.) They are grouped in Figure 241 about as outlined above but the east African group of Hamitic and Semitic peoples has been separated from the Nilotic Negroes and shown in division 5, and the Nilotic and Sudan Negroes placed together in division 4.

The first division includes the Bushmen, the Pygmies or Batwa and the Hottentots. The Bushmen are small people, the men seldom over 4 feet 10 inches in height. The skin is sallow and the hair tightly curled to give a

bushy appearance (Figure 242). The skin, especially in middle and old age, is very much wrinkled. They were hunters and raised no crops or domestic animals. Wild meat and insects, roots and vegetables constituted their diet. The Mtsama melon, a wild watermelon (*Citrullus vulgaris*) furnished food and drink. These melons, when buried in sand to protect them from herbivora, kept for long periods. Culturally, Bushman drawings and music stand out as distinct accomplishments. The dwellings were simple and they were by necessity nomadic.

The Hottentots differ chiefly in being of normal size, the women showing an even greater tendency to steatopygy than is shown by the Bushman women (Figure 243). They have hybridized with both the Bantu and the European. They are typically cattlemen but hunting is also important. They maintain herds of sheep and cattle and the women milk the cows and sheep. Their oval huts are moved about and they are nomadic. Wooden and earthenware vessels are made to hold milk or water. Furs and leather are used as clothing. They are musical. The areas formerly dominated by this group are shown in Figure 241, number 1.

The Pygmies or Batwa of central Africa are included here with the Bushmen. They are a hunting people, relying upon game and natural vegetable foods. They are regarded as the most primitive. Small in stature, they have long arms and short legs, broad noses and long upper lips. The distribution of the Pygmies indicates that they have long occupied the land and that they have long been a submerged race. They have lost their language and use that of the dominant Bantu with whom they are associated.

FIGURE 246.—Kikuyu warriors assembled in a long line. The plumes on the long masi-like spears signify peace times. Shields of oxhide. At the left the highly decorative headdress is of lion or monkey skin or of ostrich plumes. At the right the only special ornamentation is the white clay smeared on the body below the waist.

The second division, the Bantu, are a linguistic group but are generally thrown together racially as well, although they are apparently a mixture of many races ranging from Nigretto (Pygmies) through the Negroes to Hamitic and Semitic races. With only a few exceptions, they are agriculturists. They rely on crops such as manioc, bananas, rice, sweet potatoes, and yams. Nearer the equator and in the drier country they rely on sorghum, millet, and eleusine and livestock.

In the south the Kafirs (Zulus in the north and Xosa in the southeast) started migrations which led the Angoni north into Nyassaland, the Matabele to Southern Rhodesia, the Bechuana (Figure

244) to Bechuanaland, and Basuto to Basutoland. These people are all cattlemen and crop growers.

Western peoples quite distinct from the Kafirs were the Herero and the Ovambo. The Herero were exclusively cattle-rearing people and grew no crops. The Ovambo grew millet, beans, peas, and many other crops.

In East Africa, influenced by Zulu migrations from the south and Semitic migrations from the north and east, the Wagogo and Wachaga were driven to the mountains where they practice an intensive agriculture based on bananas, cassava, millet, yams, sweet potatoes, and a great variety of fruits and vegetables. The central lands are occupied by the Wanyamwesi, a mixed group. Along the coast, influenced by the Arabs, the Swahili predominate. Their language is Kiswahli, the language in common use by native peoples, Asiatics, and Europeans in east Africa.

Central and southern Uganda is occupied by Bantu peoples known collectively as Baganda. In Kenya the Akamba, Kikuyu (Figures 245 and 246), Swahili, and Kavorondo are Bantu peoples.

The Congo Bantus are chiefly Balunda and Baluba (Figure 247) in the south and the Bacongo in the west.

The Bantus are chiefly tillers of the soil. In the west manioc, rice, maize, sweet potatoes, bananas, groundnuts, palm, raffia, hemp, and tobacco are more predominant and in the southeast the "millets," this term usually covering a number of plants such as *Pennisetum*, eleusine and many varieties of sorghum. In general, ashes are used as fertilizer but the Ovamba use dung. In the Congo, dogs, goats, and poultry are important sources of food. Sheep are not generally raised and hogs are found mostly in the west. Cattle are confined mostly to the south and east.

FIGURE 247.—A Bantu girl of the Baluba tribe, wearing a sheet of Americano (calico) which is the dress of the more sophisticated natives of central and east Africa. Hair dress and arm markings are typical. Bukama, Belgian Congo.

The cattle are of the short-horned or giant-horned Zebu type.

The third division, the Sudan Negroes in the west Sudan, are a mixture of the Mande and Madinge races (Bambara, Wolof, Ewe, and the Kru [Figure 248], who are clever sailors). North of the Niger, rice, wheat and barley, maize, peas, and beans are important. In the forest regions of the south, manioc, bananas, peanuts, yams, cotton, indigo, tobacco, and cola are the chief crops. Two recent migrations have brought the Fulbe, mostly cattlemen, and the Hansa, mostly traders, into this region.

North of the Niger, the Zebu and the Moroccan ox are the chief cattle variety grown. In the Sahara, camel are important and two types of horses, the Berber Mandingo horse and the Arabian Sonrhari horse, are scattered throughout the whole of the western Sudan. The

Mohammedans use the ass as a beast of burden.

The Sudan Negroes of the East Sudan are the Bagirmi, a mixed people whose crops are chiefly millet, beans, maize, melons, groundnuts, dum palm, date palm, and cola nut. In Camen camels are bred, while farther south short-horned cattle are important. Horses are everywhere, and are especially important in Bornu, and sheep especially around Lake Chad.

The Nile Negroes include the tall Shilluk and Dinka peoples who are stock-raisers, the Bari, and the Bango who are crop-growers, and the Madi who are iron workers. Most of the Nilotic Negroes are nude. Farther west the Nyam-Nyam and Mangbattu were famous originally as cannibalistic tribes.

The mountain grasslands of the lake region are dominated by the Wahuma of Hamitic origin and from the northeast. They are cattle barons and the Bantu peoples are subjugated as crop raisers. The characteristics are distinct from the heavily built Bantu in that they reach a height of 7 feet 2 inches, are slender, narrow faced, have thin noses and often a lighter color. They include such tribes as the Watusi (Figure 249) of Urundi and Ruanda and the Bahima of Uganda. East of Lake Victoria the Masai, more negroid Hamites than the Wahuma, also rely entirely on cattle for their sustenance. Both the Wahuma and the Masai subsist largely on fresh milk and blood and on fresh meat.

The Ethiopian is Hamitic with Semitic mixtures of both Arab and Jew, the Amharas (Figure 250), an important race being of Hamitic and Jewish descent, the Somali and Galla of Hamitic and Arab descent. Amheric, Arabic, and Tigrine are the principal languages. Agriculture and livestock are both practiced.

In the northeast the Fellah are of ancient Hamitic Egyptian descent and are chiefly agriculturists. The Nubians are a mixture of Hamite, Semite and Negro. They are agriculturists, raising chiefly durra, beans, maize, wheat, barley, and lupines. The Bedouins are desert Arabs and are nomadic horsemen

FIGURE 248.—The Kru fishermen with their boats and nets are one of the few African sea-faring tribes. The canoes are dug out from a single log. They are skillful in manipulating boats in heavy seas and rough weather and have been used almost exclusively by traders in landing and receiving goods from Liberia and the Ivory Coast. Liberia. (Courtesy of the Firestone Tire and Rubber Company.)

found on both sides of the Nile as Hadendoa and as Bisharin.

East Africa has Danakil along the Gulf of Aden, Somali east of the Tana, and the Gallas in southern Ethiopia. These are all stock raisers and farmers.

The Sahara tribes are the Tuareg in the east and the Tibbu in the west. They are stock farming peoples with horses, camels, sheep, and goats. The Tuareg speak an Hamitic and the Tibbu a Sudanese language. Farther north the Arabs are nomadic cattlemen and the Berbers (Kabyles) practice chiefly agriculture and trade.

Madagascar has two distinct types of people. In the west there is a dark curly-haired negroid population, the Sakalava who are mainly cattle raisers. Their origin is still a matter for discussion; many regard them as representing the descendants of a very early migration of negroid peoples from the east and others as probably derived from African sources. Over most of the rest of the island, especially the eastern part, many tribes are grouped together as the Hova. They are Malayan peoples, fair complexioned and distinctly different from negroid peoples. They are largely agriculturists and grow such East Indian crops as rice, sugar cane, and taro.

Except for a few hunting tribes, a few traders and a few sea-faring tribes (Figure 248), the bulk of the native peoples are either herders, and livestock-growers, or crop growers. Some of the crops grow naturally but for the most part the land is tilled with the hoe. The distribution of the three principal occupational groups is shown in Figure 251. The greater part of the damp, warm country is occupied by crop-growing peoples.

In the deserts and semi-arid portions, herders prevail while a broad intermediate belt is occupied by peoples who depend partly on livestock and partly on crops. Where two races live together and one is composed of stockmen and the other crop-growers, the stockmen are always the dominant race. This is especially true in the highlands of east central Africa where the Wahima cattle barons and the Whutu crop-growers live in the same area.

FIGURE 249.—Watusi men. From left to right, sons of Chief Binga: Kumpi, Vimya, Savivya, Bikama, and Ndagaswa, and four sons of Chief Mlinga. All are dressed in bark cloth, but the third, fifth, sixth, eight, and ninth have added a sheet of Americano (calico). They range from six to seven feet in height. Nyanza, Urundi.

It is probably true that wherever possible the African raises livestock and that for the most part crop-growing is resorted to as a result either of pressure of overlords or of unfavorable climatic conditions, or the presence of the tsetse fly.

AFRICA'S PLACE IN WORLD AGRICULTURAL POTENTIALITIES

The agricultural potentialities of the African continent can be roughly compared with the rest of the world on the basis of natural vegetation. Although maps are all generalized and not very accurate, the broad phases of the picture are clearly seen. In Table XI are given estimates of the various formation groups of natural vegetation for the world area, the African area, the United States, and for South America. The figures are for natural vegetation

and do not consider destruction by cultivation and lumbering. Since the purpose is to compare the physical base of soil and climate for agricultural production, this method is justified. South America and the East Indies compare more directly with Africa than do North America and Eurasia. The United States is included in the estimates only by way of comparison.

The tropical rain forest belt (Figure 252) is valuable for the production of tropical timber, cacao, rubber, bananas, and tropical fruits and vegetables. It covers in Africa about 900,000 square miles or nearly one-fourth of the world area. This great area is warm-weather crop land.

Most nearly related to the tropical rain forest is the high grass savanna (Figure 252). Here can be grown almost any of the crops produced in the rain forest except those needing protection from sun and air currents. Africa has about 1,471,000 square miles of this type of country or over half of the world area. This land is better grazing land in South America than in Africa due to the tsetse fly infection in Africa.

The tropical rain forest and high grass savanna combined represent the bulk of the warm, damp tropical agricultural lands and total roughly 6,600,000 square miles for the world area and 2,461,000 square miles for Africa, which is over a third of the world area.

The temperate rain forest and the mountain grassland (Figure 253) belong together from an agricultural point of view. Productive of bananas, coffee, and almost any temperate crop, they are probably the most desirable lands of the tropics due to the temperate climate and richness of the lands and

FIGURE 250.—A market scene with a typical Amhara man at the right. They are clothed in homespun cotton cloth. Addis Ababa, Ethiopia.

the grazing values of the grasslands. Together these groups occupy about 1,340,000 square miles on a world basis and Africa has about 417,000 square miles of this area, or nearly a third of the world area.

The tall grass savanna and the dry forest (Figure 254) are similar from an agricultural point of view. It is the warm-weather grain belt, and produces such valuable crops as cotton, peanuts, and livestock. The world area is about 5,900,000 square miles. Of this, Africa has about 3,087,000 square miles, or over half of the world area. This is excellent grazing land, but in Africa, especially in the dry forest type, cattle are often shut out because of tsetse fly.

Sclerophyll brushland (Figure 253) is especially important since here has

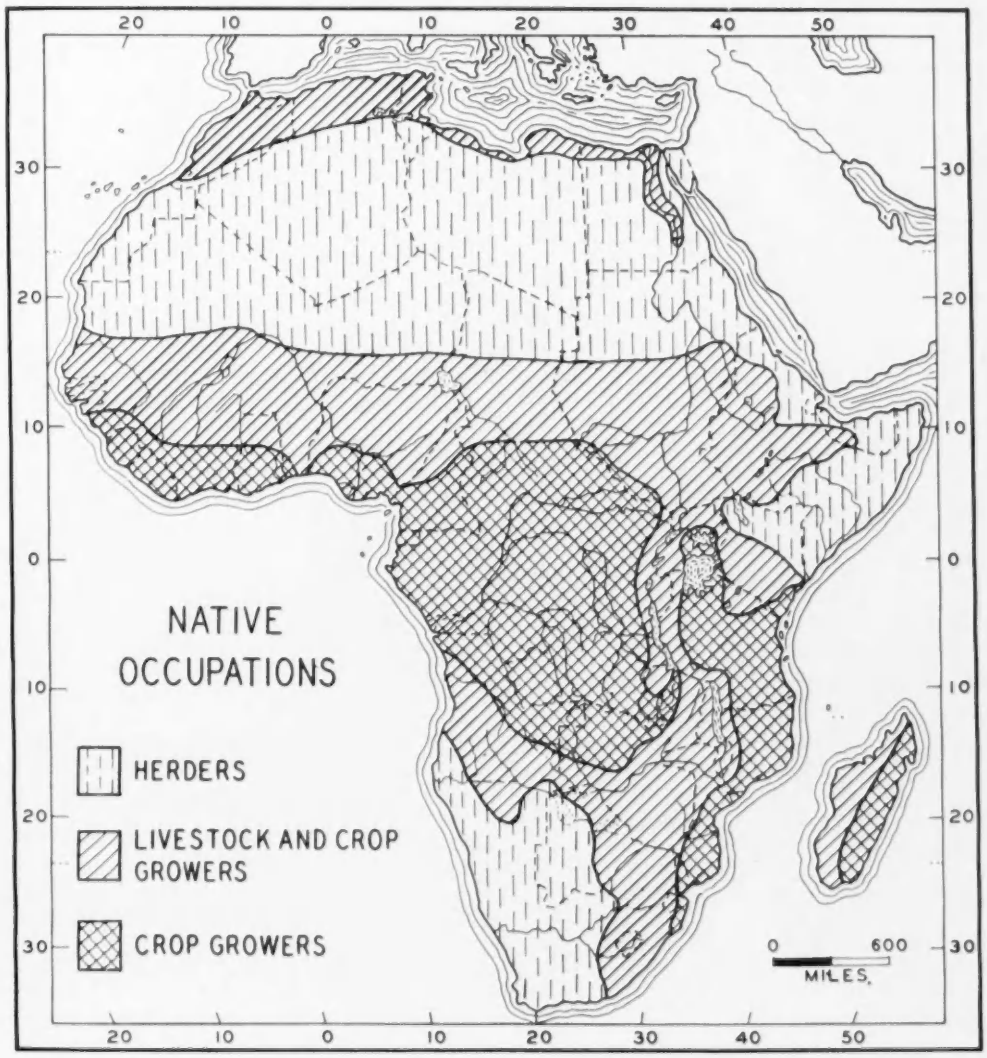


FIGURE 251.—The native peoples may be divided into: (1) herders; (2) livestock and crop growers; and (3) crop growers. In general the herders occupy the deserts of the north and northeast and the southwest. The crop growers occupy the warm damp central lands, the Guinea coast, and the east coast south of the Equator. The livestock and crop growers use the land lying between these two extremes.

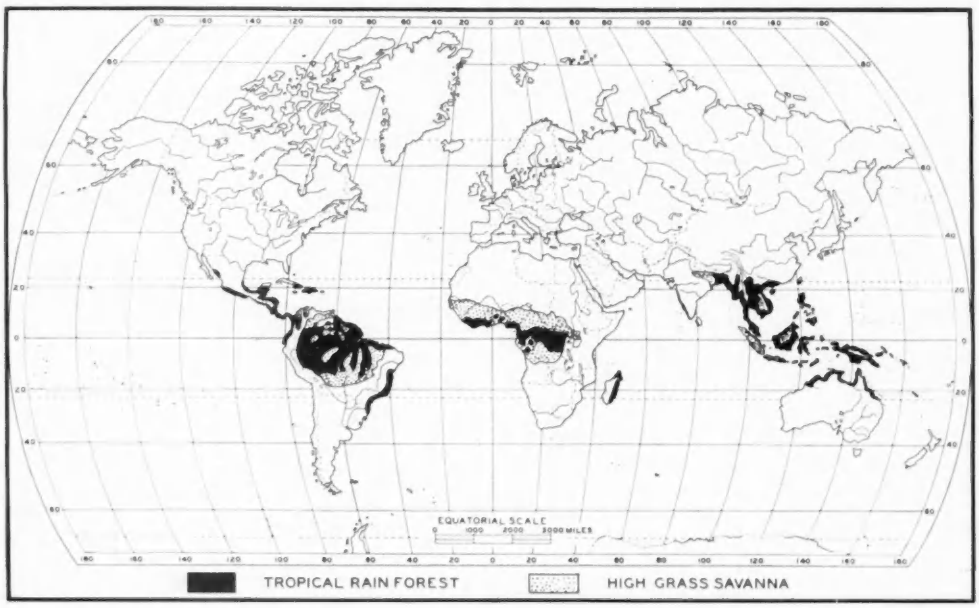


FIGURE 252.—Vegetation of the world. Tropical rain forest and high grass savanna.

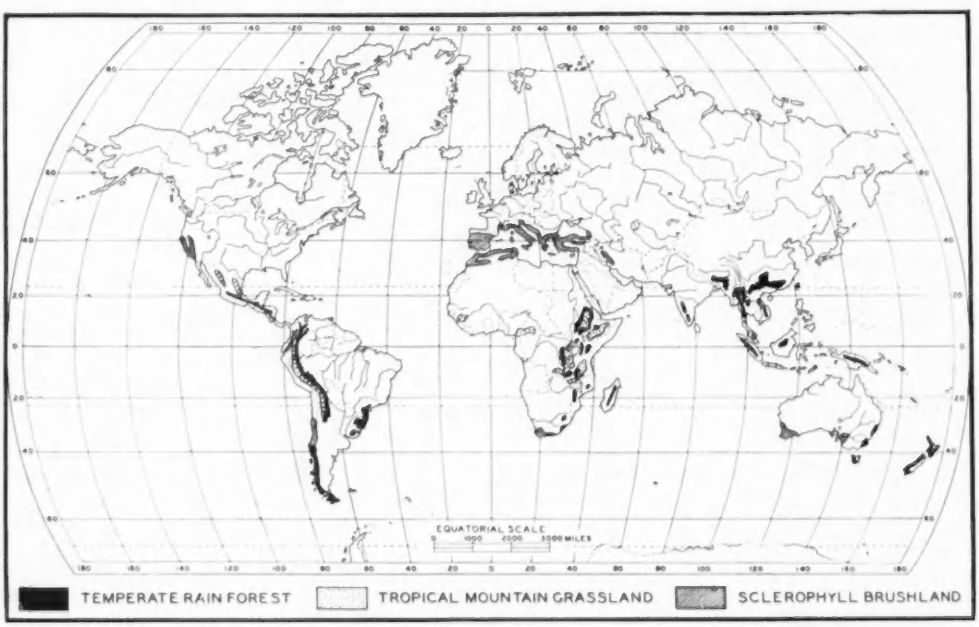


FIGURE 253.—Vegetation of the world. Temperate rain forest, tropical mountain grassland, and sclerophyll brushland.

been developed a sub-tropical agriculture where warm-weather crops do well in summer and cool-weather crops well in winter. Notwithstanding the rather poor non-calcic brown soils these areas have throughout the world been prized as the habitation of modern man. The world area of this type is roughly about 1,178,000 square miles. Africa has about 210,000 square miles or nearly a

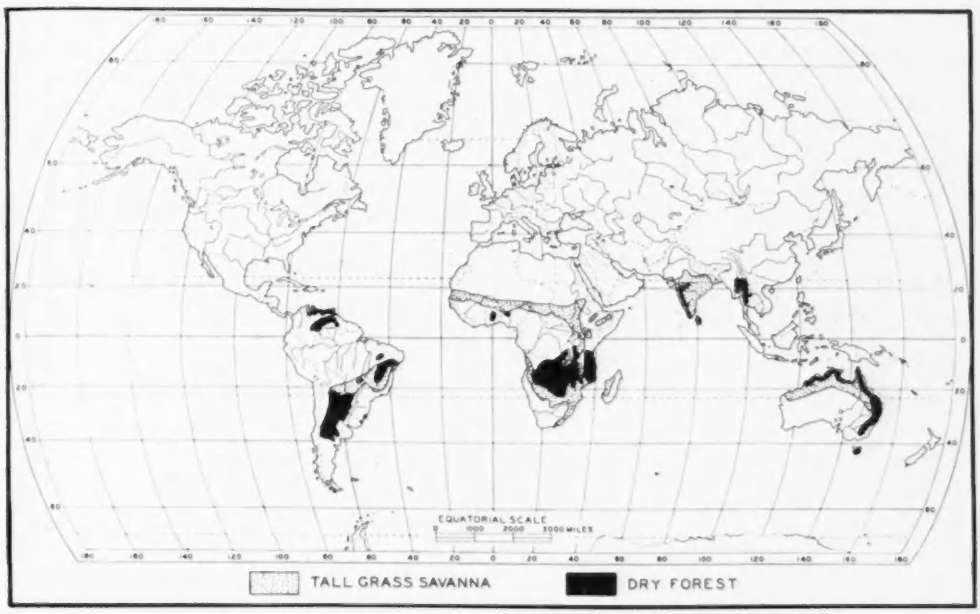


FIGURE 254.—Vegetation of the world, showing tall grass savanna and dry forest.

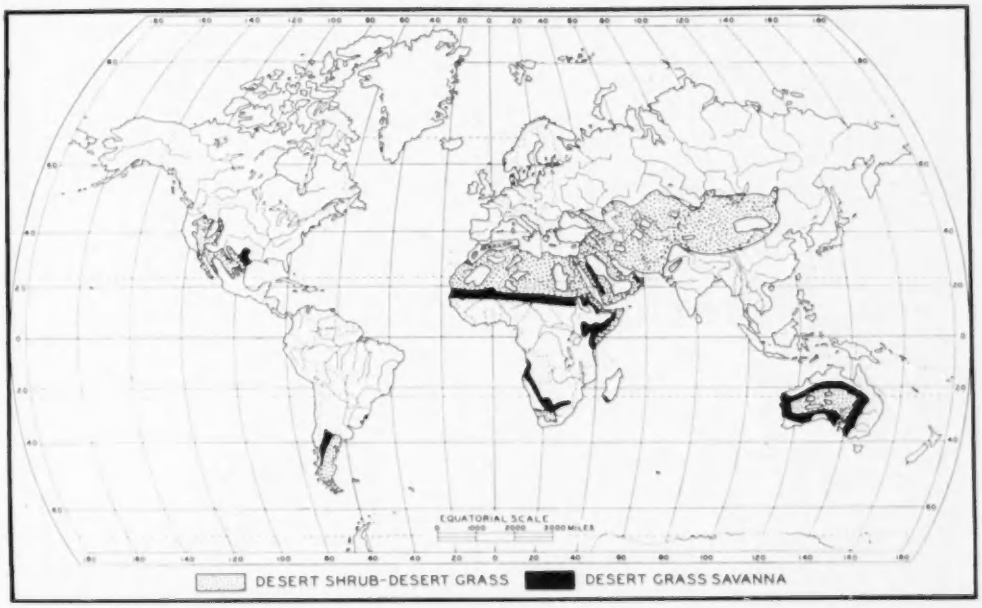


FIGURE 255.—Vegetation of the world, showing desert shrub-desert grass and desert grass savanna.

fifth of this type of land. In this calculation the temperate brush and dwarf palm-temperate grass are combined since the latter is merely a cleared stage of the former.

Another group valuable chiefly for the production of gums and for grazing is the desert shrub-desert grass and the desert grass savanna (Figure 255). It is valuable land for wildlife and for grazing by cattle, sheep, goats, and camels. The world area is about 12,900,000

TABLE XI

NATURAL VEGETATION OF AFRICA, THE WORLD, SOUTH AMERICA AND THE UNITED STATES
AREAS EXPRESSED IN 1,000 SQUARE MILES

	AREA				FOREST				WOODLAND			
Forest:	*World*	*Africa*	*U.S.*	*S. Amer.*	*World*	*Africa*	*U.S.*	*S. Amer.*	*World*	*Africa*	*U.S.*	*S. Amer.*
Tropical Rain Forest	3,800	900	...	2,200	3,800	900	...	2,200	...	...	...	...
Temperate Rain Forest	550	96	...	280	550	96	...	280	...	...	...	...
Deciduous Forest	6,500	14	630	...	6,500	14	630	...	...	...	...	...
Coniferous Forest	7,600	14	810	...	5,500	14	660	...	2,100	...	150	...
Dry Forest	2,000	1,054	...	750	2,000	1,054	...	750	...	...	...	...
Thorn Forest	330	192	...	150	...	...	...	...	330	192	...	150
Sclerophyll Brushland	1,178	210	40	32	...	...	...	...	1,178	210	40	32
Total	21,958	2,480	1,480	3,412	18,350	2,078	1,290	3,230	3,608	412	190	182
Grassland:												
High grass savanna	2,800	1,471	...	1,200	...	...	...	...	...	...	...	...
Tall grass savanna	3,900	2,033	...	620	...	...	...	...	...	...	...	...
Tall grass	1,581	94	480	500	...	...	...	...	...	...	...	...
Short grass	1,200	...	420	...	...	...	...	...	...	...	...	...
Desert grass savanna	2,300	1,252	140	120	...	...	...	...	...	...	...	...
Mountain grassland	790	321	...	110	...	...	...	...	...	...	...	...
Total	12,570	5,171	1,040	2,550	...	...	...	...	...	...	...	...
Desert:												
Desert shrub and desert grass	10,600	2,915	420	250	...	...	...	...	...	...	...	...
Desert	2,400	773	...	190	...	...	...	...	...	...	...	...
Salt desert shrub	30	7	14	...	...	...	...	...	...	...	...	...
Tundra	4,400	...	...	...	...	...	...	...	...	...	...	...
Total	17,430	3,695	434	440	...	...	...	...	...	...	...	...
Grand Total	51,958	11,346	2,954	6,502	18,350	2,078	1,290	3,230	3,608	412	190	182

square miles. Of this area, Africa has about 4,167,000 square miles, or nearly a third of the world area.

Types not well represented in Africa are the deciduous and coniferous forests with only about 28,000 square miles in Africa and the tall grass and short grass which occupy only about 94,000 square miles. Tundra is absent.

The world's forests of about 18,350,000 square miles are represented in Africa by only about 2,078,000 square miles or only about 11 per cent of the world area. Woodlands are about the same, the world area being roughly 3,608,000 square miles of which Africa has about 412,000 or about 11 per cent of the world area.

Of the lands suitable for grazing 26,185,000 square miles is roughly the world area. Africa has about 9,143,000 square miles or a little over a third of the world area.

Cool-weather crop land occupies about 11,778,000 square miles. Africa has only about 735,000 square miles of this type of land or only about 6 per cent of the world area. Much of this area can produce such tropical crops as coffee and bananas in addition to the temperate grains, fruits, and vegetables.

Warm-weather crop land exceeds slightly the cool-weather crop land and amounts to about 12,730,000 square miles for the world area. Africa has 5,458,000 square miles of this type of land or 43 per cent of the world area.

On the basis of total land suitable for crop production, the world area is roughly 24,508,000 square miles. Of this area Africa has 6,193,000 square miles, or about 28 per cent of the world area.

TABLE XI—(*Continued*)

NATURAL VEGETATION OF AFRICA, THE WORLD, SOUTH AMERICA AND THE UNITED STATES
AREAS EXPRESSED IN 1,000 SQUARE MILES

GRAZING LAND				*CROP LAND*											
				Cool Weather				*Warm Weather*				*Total*			
World	*Africa*	*U.S.*	*S. Amer.*	*World*	*Africa*	*U.S.*	*S. Amer.*	*World*	*Africa*	*U.S.*	*S. Amer.*	*World*	*Africa*	*U.S.*	*S. Amer.*
...	...	...	...	...	...	...	...	3,800	900	...	2,200	3,800	900	...	2,200
...	...	...	...	550	96	...	280	...	...	...	...	550	96	...	280
...	...	...	...	6,440	14	610	...	60	...	20	...	6,500	14	630	...
1,000	...	300	...	40	...	10	...	30	...	30	...	70	...	40	...
2,000	1,054	...	750	...	...	...	...	2,000	1,054	...	750	2,000	1,054	...	750
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	1,178	210	40	32	...	...	...	...	1,178	210	40	32
3,000	1,054	300	750	8,208	320	660	312	5,890	1,954	50	2,950	14,098	2,274	710	3,262
2,800	1,471	...	1,200	...	...	...	...	2,800	1,471	...	1,200	2,800	1,471	...	1,200
3,900	2,033	...	620	...	...	...	...	3,900	2,033	...	620	3,900	2,033	...	620
1,580	94	480	500	1,580	94	480	500	...	...	...	...	1,580	94	480	500
1,200	...	420	...	1,200	...	420	...	...	...	...	...	1,200	...	420	...
2,300	1,252	140	120	...	...	...	...	140	...	70	...	140	...	70	...
790	321	...	110	790	321	...	110	...	...	...	...	790	321	...	110
12,570	5,171	1,040	2,550	3,570	415	900	610	6,840	3,504	70	1,820	10,410	3,919	970	2,430
10,600	2,915	420	250	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
15	3	7	...	...	...	...	...	...	...	...	...	...	...	...	...
...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
				...	...	...	...	...	...	...	...	...	...	...	...
10,615	2,918	427	250	...	...	...	...	...	...	...	...	...	...	...	...
26,185	9,143	1,767	3,550	11,778	735	1,550	922	12,730	5,458	120	4,770	24,508	6,193	1,680	5,692

Very little of the land in Africa can be directly compared with the United States. The oak forest and coniferous forests of limited extent in the north are similar to California forests. In the Cape and Mediterranean regions there are 210,000 square miles of land similar to the 40,000 of chaparral in California.

The tall grass of Africa amounts to about 94,000 square miles and in the United States to about 420,000 square miles. The tall grass of the transvaal and Orange Free State is similar to that of Oklahoma and Texas.

Desert grass savanna occupying 1,252,000 square miles is similar to the mesquite-mesquite grass of Texas which covers about 140,000 square miles.

Desert shrub and desert grass cover 2,915,000 square miles in Africa and 420,000 square miles in the United States. Ecologically the southern desert shrub area most resembles the African areas.

South America has more than twice as much tropical rain forest and temperate rain forest as Africa. In dry forest and thorn forest Africa exceeds South America.

The high grass savanna of Africa exceeds that of South America in area, and the tall grass savanna is three times as extensive in Africa as in South America. The tall grass of South America is five times as extensive as in Africa.

The area of desert grass savanna is ten times greater in Africa than in South America, and the desert shrub-desert grass also ten times as great.

The temperate rain forest and mountain grassland, the great coffee producing area, totals about 417,000 square miles in Africa and 390,000 square miles

in South America. This is a most important type where coffee and cool-weather crops do well.

Other groups such as the tropical rain forest and high grass savanna total 2,371,000 square miles in Africa and 3,400,000 square miles in South America. This is productive of tropical timber, cacao, rubber, banana, and tropical fruits and vegetables.

The dry forest and tall grass savanna, the cereal and livestock belt totals 3,087,000 square miles in Africa and 1,370,000 square miles in South America.

In brief, Africa has nearly a fourth of the tropical timber and over a third of the warm humid tropical agricultural land, nearly a third of the cool-weather crop land of the tropics, over half of the warm-weather grain land, a fifth of the Mediterranean type of fruit and cereal land, and a third of the low capacity grazing land of the world. On a combined basis it has 11 per cent of the world's forest land, a third of the world's grazing land, 6 per cent of the world's cool-weather crop land, 43 per cent of the world's warm-weather crop land, and 28 per cent of the total potential crop land area of the world.

HAIL IN AMERICAN AGRICULTURE

Hoyt Lemons

THE farmer of the Plains of Kansas views the brewing thunderstorm with mixed emotions. Rain he must have, yet the wildly agitating clouds may bring hail in addition. The rain he needs desperately —the hail he dreads even more desperately. These hardened slugs of ice flatten fields of grain, rip through roofs, and even snuff out lives of farm animals. A missile the size of an orange or grapefruit driven by a 100 mile an hour wind is, indeed, a formidable instrument of destruction.

Poleward and equatorward, toward the Atlantic and toward the Pacific, the danger of hail is attenuated. (See Hoyt Lemons, "Hail as an Element in the Climatology of High and Low Latitudes," *Bull. Am. Met. Soc.*, Feb. 1942.) Although no parts of the United States are secure from its unwelcome visitations, only in a few areas, albeit the best agricultural ones, is hail considered one of the more formidable of our climatic hazards.

National Significance of Hail

The economic, social, and political implications of losses from hail are national in scope. Crops, livestock, and real property sustain extensive damages each year. Over a 17-year period, 1909–1925, seven of our leading crops suffered losses aggregating some $46,000,000, according to United States Crop Reporters (Table I). Damage to corn, oats, wheat, barley, and apples each amounted to millions of bushels and that to cotton to thousands of bales annually. Although $46,000,000 is a modest figure nowadays, it represented more than one per cent of the average yearly national agricultural income. The total, moreover, does not include damage to minor crops, to livestock, and to real property. The addition of these would boost the grand total of loss to a much more formidable level. (An extensive survey of hail insurance losses currently conducted by the author indicates that mean annual losses to farmers from hail may be well over $100,000,000.) Furthermore, it should be recalled that all agricultural regions in the country do not share equally in those losses. Some of the best farming regions have tremendous amounts of damage, while in other areas hail is scarcely considered a hazard.

Regional Discussion of Hail

Comparative regional economic significance of hail is illustrated by maps of damaging hailstorms (Figures 2 and 3). These maps are based on data collected by United States Crop Reporters. Only the hailstorms causing material damage (chiefly to field crops) are included. Their mean regional frequencies for the growing season are also presented (Figure 4).

The entire central portion of the country from the Rockies to the Appalachians has substantial numbers of damaging hailstorms each year. Within this territory, the Great Plains and the Central Lowland are most severely afflicted. Three basic factors are involved: (1) These regions have the highest hail frequencies of any regions in the country. Practically all weather bureau stations there report mean annual frequencies of two to four hailstorms.

TABLE I

CROP-LOSS FROM HAIL IN THE UNITED STATES, 1909 TO 1925

Year	*Wheat (in thousand bushels)*	*Oats (in thousand bushels)*	*Barley (in thousand bushels)*	*Flaxseed (in thousand bushels)*	*Corn (in thousand bushels)*	*Cotton (in thousand bales)*	*Apples (in thousand bushels)*
1909	18,100	15,100	5,100	....	18,300	103	....
1910	4,800	6,200	2,800	300	15,600	55	....
1911	4,000	4,600	1,100	300	7,600	21	....
1912	16,000	17,200	5,300	1,100	21,200	122	3,100
1913	7,000	9,700	2,700	500	12,000	86	1,900
1914	11,100	12,600	3,500	400	19,300	86	2,100
1915	20,400	18,500	4,300	400	25,600	125	4,300
1916	13,500	13,800	3,900	300	15,700	139	4,400
1917	10,000	15,900	3,500	300	27,800	189	3,300
1918	13,600	17,400	4,000	500	16,100	20	2,200
1919	12,400	11,800	4,300	400	11,300	39	3,000
1920	12,300	14,300	2,700	300	19,100	44	7,200
1921	17,100	14,100	2,900	300	15,100	34	1,700
1922	24,300	18,500	3,700	300	34,000	54	2,000
1923	15,800	15,000	3,800	600	23,900	112	2,200
1924	15,500	21,300	3,900	700	53,600	42	3,000
1925	11,900	19,000	3,700	600	24,000	129	3,000
Mean Annual Bu....	14,500	15,400	3,800	500	23,700	82 bales	2,800
Mean Annual Value.	$12,905,000 (@ 89¢ bu.)	$5,852,000 (@ 38¢ bu.)	$2,128,000 (@ 56¢ bu.)	$930,000 (@ $1.86 bu.)	$15,642,000 (@ 66¢ bu.)	$5,330,000 (@ 13¢ lb.)	$3,024,000 (@ $1.08 bu.)

Total Mean Annual Loss—$45,811,000

Source: Crop Reporters' Estimates, U. S. Dept. of Agri.; from Kincer, J. B., "Is Our Weather Changing," Illinois Farmers' Institute, 1937–38. (Monetary computations by author.)

(2) These areas contain the most extensive agricultural lands of the nation, and the broad acres of growing crops are excellent potential sources of hail damage. (3) The majority of the crops are in the fields during the period of the year when hailstorm frequency is highest, that is, in spring and summer. (For descriptive and explanatory discussion of the time-areal distribution of hail in this country see Hoyt Lemons, "Hail as a Factor in the Regional Climatology of the U. S.," *Geographical Review*, July, 1942.) United States Weather Bureau records reveal that 90 per cent of the mean annual loss from hailstorms occurs during the six months of the warm season, April 1 to September 30. June, one of the two months of highest hail frequency, is the month of greatest damage.

A survey of the planting and harvesting dates of the principal crops, furthermore, serves to impress one with the importance of hail as a climatic hazard to agriculture in the Midwest. Originating in the Gulf Coast region in early spring, hailstorms develop progressively northward, accompanying the northward unfolding of the growing season. Throughout large parts of the growth periods of our principal crops, hailstorms constitute an ever-present menace. Harvest is general in the southern part of the hard winter wheat region by mid-June and in the central part by late June and early July. Hailstorms are common there by late April. In the spring wheat region of the Northern Plains harvest is not general until early August although hail is common by late May. In these two important regions, therefore, wheat is in the fields and subject to hail for a period of one to two months or more.

Hail of April and early May has little effect on corn in the Corn Belt because hail activity is still slight there and corn

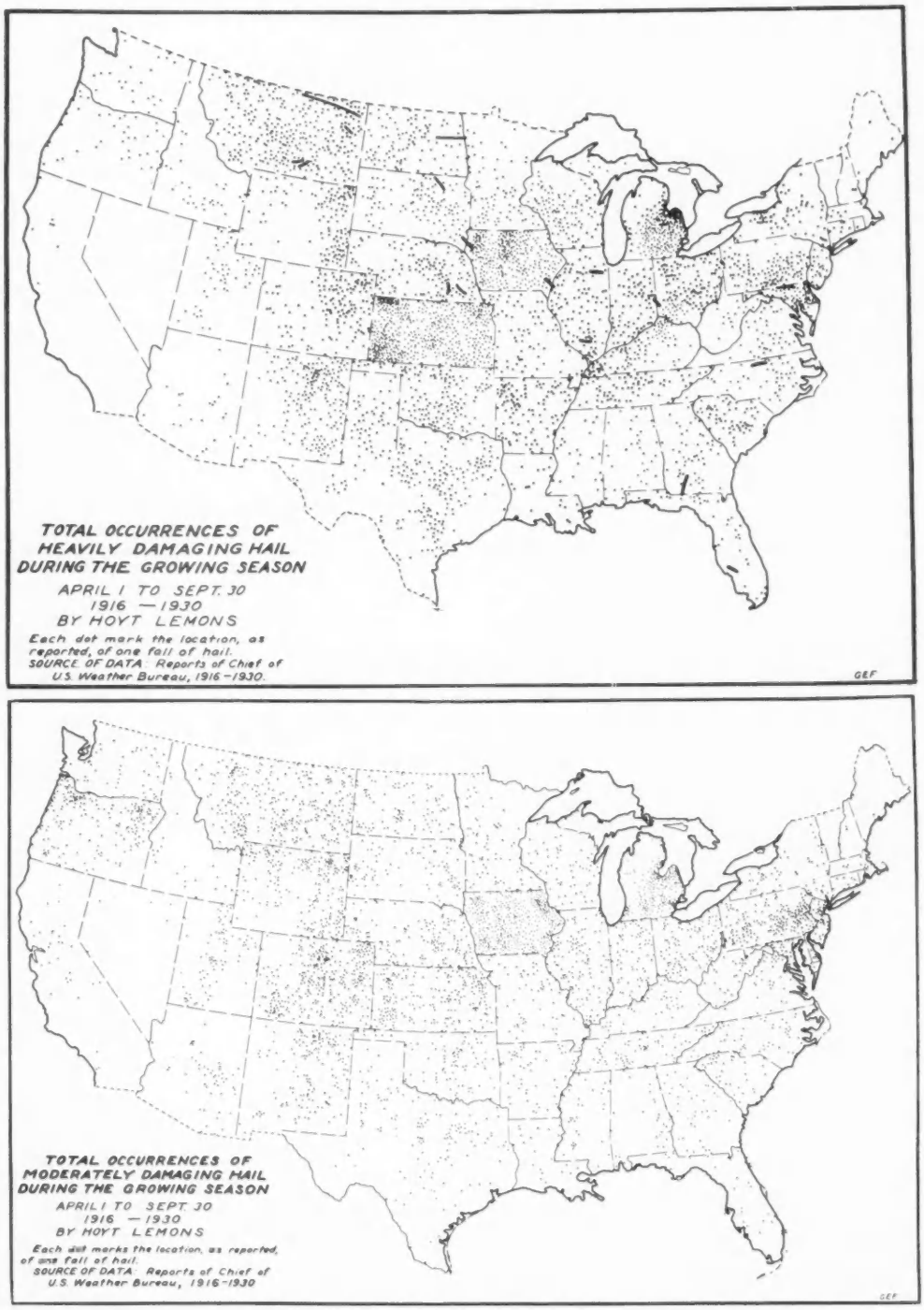
planting is not finished until late May. Although hail frequency becomes highest in late May and early June, it slackens during July and August when corn, in the tasseling and ear-filling stages of growth, is most susceptible to injury by hailstones. Nevertheless, corn is subject to damage for a period of two to three months.

Cotton planting is general in the southern part of the Cotton Belt by the first of April and in the northern part by mid-April, while picking becomes general throughout in late August and September. Parts of the Cotton Belt, therefore, are subject to hail for four months. Hail forms the worst hazard to this crop, however, in the Plains portion of the Belt where hail frequency is highest. Much of the hail area migrates northward before the cotton plants attain any considerable size. Although the worst storms occur north of the Cotton Belt, for two or three months during early growth cotton is subject to them (Figure 5).

From the Ohio Valley eastward to the Piedmont and Coastal Plains of the Atlantic, tobacco is transplanted from beds to the fields during middle and late May. About three months after transplanting it is ready to cut and house, indicating that the bulk of the tobacco crop is in the fields and subject to hail for a period of two and one-half months or more. Most of the tobacco areas, however, are situated in regions of relatively low hail frequency. Nevertheless, occasional storms produce tremendous damage because of the ease with which the leaves of the plant are injured (Figure 6).

Damaging hailstorms are more frequent in the Great Plains and are more significant to the economy of that region than to any other region of the country (Figure 4). In the southern Plains cotton, wheat, fruit and vege-

FIGURE 1.—Hail two feet deep which fell during a local thunderstorm at Trinidad, Colorado, June, 1937. Although considerable hail occurs in middle latitude mountains, little damage results because of the small extent of crops and real property.


TOTAL OCCURRENCES OF
HEAVILY DAMAGING HAIL
DURING THE GROWING SEASON
APRIL 1 TO SEPT. 30
1916 — 1930
BY HOYT LEMONS
Each dot mark the location, as
reported, of one fall of hail.
SOURCE OF DATA: Reports of Chief of
U.S. Weather Bureau, 1916-1930.
GEF
TOTAL OCCURRENCES OF
MODERATELY DAMAGING HAIL
DURING THE GROWING SEASON
APRIL 1 TO SEPT. 30
1916 — 1930
BY HOYT LEMONS
Each dot marks the location, as reported,
of one fall of hail.
SOURCE OF DATA: Reports of Chief of
U.S. Weather Bureau, 1916-1930
GEF

FIGURES 2 AND 3.—Hailstorms have economic significance when they produce damage to property. The maps, Figures 2 to 4, show that over a long period of time crop-damaging hailstorms have been more numerous in some areas than in others. Data for these maps were gathered by some 5,000 coöperative and regular weather bureau stations over the country. Falls of hail too light to produce damage were omitted. The large number of dots in Kansas and Iowa are due to some extent to the unusually large number of reporters in those states.

tables are the principal crop victims. Texas experiences a mean total of 26 damaging storms during the average growing season, 17 of them being of the heavily damaging type. In Oklahoma nine of a mean total of 15 damaging storms are of the more serious type. New Mexico's average is 23, about half being of the heavily damaging variety. In that state, storms are most numerous in the agricultural eastern or Plains region (Figures 2 and 3). This situation is true in Colorado, Wyoming, and Montana as well. The crops afflicted most frequently in New Mexico are fruit and cotton, according to meteorologist Hardy of the Albuquerque Weather Bureau Office. The wheat and cotton regions of Central Texas and Oklahoma have the greatest numbers of damaging storms in those states (Figures 2 and 3). In Oklahoma the extensive losses caused by hail led to the establishment of a state hail insurance department which was subsequently forced out of existence by inability to compensate claims.

Although damaging hailstorms are frequent in the southern Great Plains, they are experienced in greatest numbers in the central portion of that province (Figure 4). Kansas experiences more damaging storms than any other state. For the state as a whole, 50 damaging storms occur each year (Figure 4A). This figure is probably extremely low as many storms are never reported. Evidence indicates that damaging storms actually occur by the hundreds each year.

The extensive wheat area of central and western Kansas accounts for most of the hail loss. The crop approaches maturity during the period of greatest hail activity. A survey over an 18-year period indicates that average losses to wheat in most counties of the wheat region range up to 20 per cent of the crop, with the normal loss probably being 5 to 10 per cent (Figure 7).

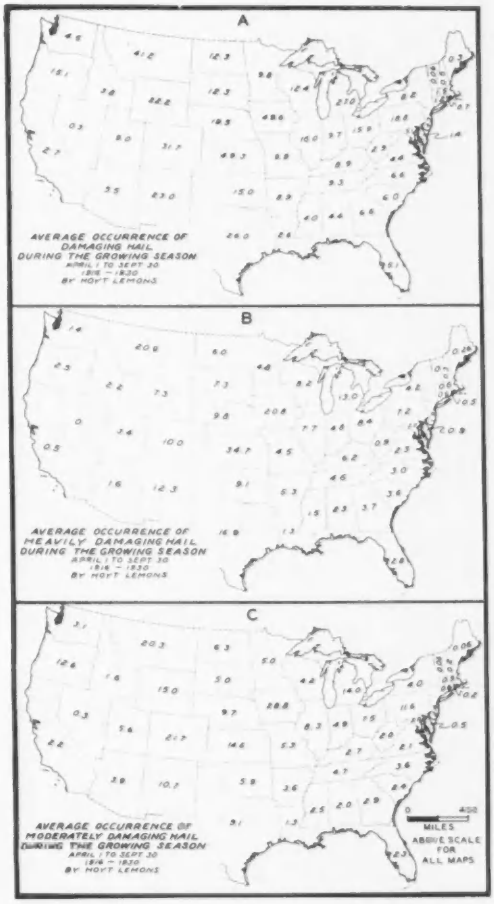

A
AVERAGE OCCURRENCE OF DAMAGING HAIL DURING THE GROWING SEASON APRIL 1 TO SEPT 30 1916 - 1930 BY HOYT LEMONS
B
AVERAGE OCCURRENCE OF HEAVILY DAMAGING HAIL DURING THE GROWING SEASON APRIL 1 TO SEPT 30 1916 - 1930 BY HOYT LEMONS
C
AVERAGE OCCURRENCE OF MODERATELY DAMAGING HAIL DURING THE GROWING SEASON APRIL 1 TO SEPT 30 1916 - 1930 BY HOYT LEMONS
0 400 MILES
ABOVE SCALE FOR ALL MAPS

FIGURE 4.—Average occurrence of crop-damaging hailstorms by states. That some states are more afflicted with more highly damaging storms than others is illustrated by maps B and C.

Losses from hail in Kansas frequently total six or eight million dollars per year. In 1928 six different storms each produced $1,000,000 damage. In 1927 one storm caused $2,000,000 damage to 30 square miles of ripened wheat which was ready for cutting. Spectacular though the large storms are, they are not the ones which cause the bulk of damage year in and year out. This is accomplished by the hundreds of minor storms. In the *Monthly Weather Review* for 1929, Flora gives a vivid description of the detailed effects of such a storm: " . . . The total loss was valued at

$150,000. Along the path of severest hail, wheat was a complete loss and the oats destroyed in some places. The grain was hammered into the ground until in some fields not a stem was left standing. Chickens, ducks, and geese, as well as birds, pigeons, and jack rabbits perished literally by the hundreds."

Actual measurement of hailstones in some Kansas storms has revealed stones ten inches in diameter, the force of which meets small resistance from growing plants, from house and automobile roofs, and from other property. Hailstones, of course, are not alone accountable for all the damage occurring during the passage of the storm. The accompanying wind plays a significant role.

The eastern or Great Plains portion of Colorado receives so many hailstorms that the state has seen fit to institute a hail insurance department (Figure 1). Corn, sugar beets, potatoes, fruits, vegetables, wheat, oats, and barley are injured extensively here. On one occasion in 1928, a single hailstorm caused over $2,000,000 damage to fruit and sugar beets.

In the northern Plains hailstorms are important although less so than in the central portion (Figure 4). Here again, in those states whose areas are divided between the Rocky Mountains and the Great Plains, damaging storms are most numerous in the latter province (Figures 2 and 3). A majority of Wyoming's mean annual total of 22 is experienced there. Montana has the surprisingly high total of 41, about half of them being heavily damaging storms. Insurance records show that in bad hail years the average loss to wheat in that state may run as high as 10 to 15 per cent of the total crop. The Dakotas receive 12 and Nebraska 20

FIGURE 5.—Even outside the main hail areas hailstorms frequently damage growing crops and other property. This is a Georgia cotton field after destruction of the crop by hail. (Courtesy of Western Hail and Adjustment Association.)

damaging storms per year, these being equally divided in each instance between lightly and heavily damaging types. The cereals, forage crops, and sugar beets are the principal victims in the northern Plains (Figures 8 and 9).

The Central Lowlands are second only to the Great Plains in frequency of damaging hailstorms (Figure 4). The actual occurrence of storms is less in the Lowlands than in the Plains. The northerly location of the Lowland gives freedom from the severe storms of early spring. Most of the states of the Lowlands average 10 to 15 damaging storms for the growing season. An instance of a storm which occurred at the southern edge of the Lowland exemplifies the more severe storms of the region. This is cited from the *Bulletin of the American Meteorological Society* for 1931:

"Hailstones as big as baseballs, falling with such force as to strip homes of weather boarding, kill poultry, birds, and livestock, were reported on June 5 in the Ozark farming community of Passo. In the road leading to Passo, ice a foot thick formed from the hailstones and residents said that the hail piled up at least three feet deep immediately after the storm."

Iowa has a mean annual total of 50 damaging storms but, unlike Kansas, less than half are of the seriously damaging type (Figure 4). Iowa deserves extra detail in a discussion of the regional frequency of damaging hail, not only because of the magnitude of its losses, but also because of the excellent record which has been maintained there for a number of years. Assessors in Iowa are required to ask each of about 210,000 farmers the amount of hail damage to crops on his farm during the preceding season. These data are summarized by the Weather Division of the Iowa State Department of Agriculture. A survey of the 16-year period, 1923–38, was published under Climatological Data by the Des Moines Weather Bureau Office in 1939. Over that period, the mean annual loss was $3,266,773, while the average value of crops at risk was $309,925,980 (Figure 10). The percentage of damage averaged 1.05 per cent, varying from 2.13 per cent in 1932 to 0.30 per cent in 1935. The single highest loss, $7,975,686, occurred in 1925, and one severely destructive storm accounted for $5,000,000 of that total. The smallest annual damage, slightly under $1,000,000 was recorded in 1935. In 1929, a single county reported more than a million dollars damage. Over the 16-year period, 30 per cent of all townships reported hail damage yearly. Mean annual damage increases from east to west across the state. Damage in Iowa, as in the other Corn Belt states, is principally to corn and small grain.

FIGURE 6.—A tobacco field at Ringold, Virginia, showing damage produced by hailstones. The tender tobacco leaf, which is the commercial product of the plant, is easily and extensively injured by even light falls of stones. Cheesecloth and other tobacco-shading materials are also easily damaged. (Courtesy of Western Hail and Adjustment Association.)

Among the northern states of the Central Lowland, Wisconsin has in the 65,000,000 pounds of tobacco it produces each year, the elements of great potential loss. When hailstones fall upon tobacco in full leaf in late summer

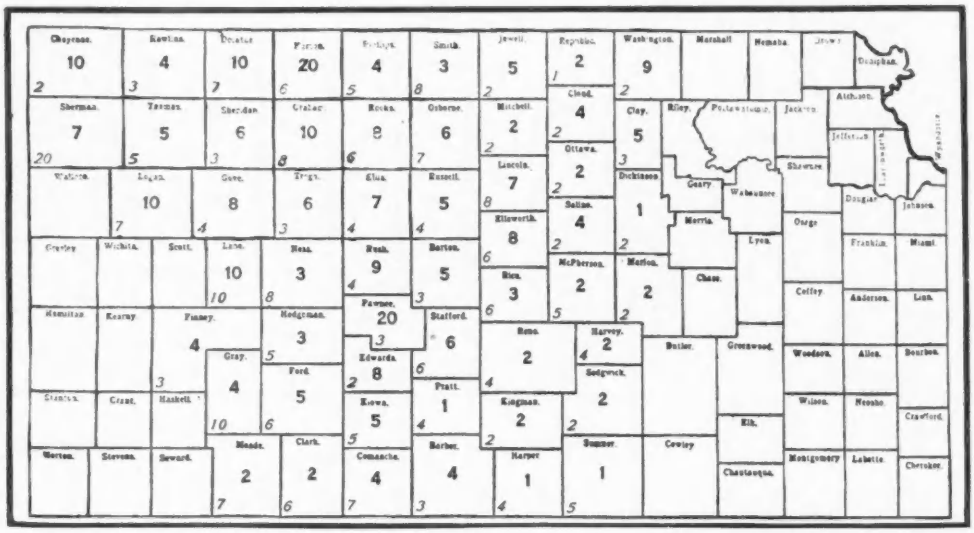


FIGURE 7.—Percentage of wheat crop in Kansas damaged by hail during the past eighteen years (by counties) as inferred from the records of the most important hail insurance company of that state. Figures in italics give the percentage of the wheat crop of each county that was insured in this company. (Courtesy of S. D. Flora, *Monthly Weather Review*.)

months the damage is extensive (Figure 6). Occasionally, also, hail damages fruit blossoms and strawberries in spring, mature apples in June and July, and vineyards in the fall. Some effect of water bodies in preventing hail formation is illustrated by the paucity of hail damage in the important fruit region of the western portion of the lower peninsula of Michigan (Figure 11). In the lesser important fruit area of the eastern side of the peninsula near Lake Huron, damage is heavy. Seeley and Dole in an article entitled "Hailstorms in Michigan," in the *Monthly Weather Review* for 1924, draw interesting conclusions on the reasons for this:

"(1) The number of hailstorms along the windward shore of the lower peninsula are remarkably small. (2) The area having the greatest number of storms extends in a southwest-northeast direction in the shape of a fan, with the extreme totals at some distance from Lake Michigan, across which the prevailing wind blows. *This proves conclusively that the Lakes are effective agents in preventing the vertical circulation which produces hailstorms and tornadoes.*" In Minnesota severe hailstorms occur, although infrequently, as far north as Duluth. In 1929 stones "larger than baseballs" fell with such velocity as to make holes three and four inches deep in the Weather Bureau lawn.

Agriculture of the Pacific Coast region is not afflicted with hail. This area produces numerous crops of high value per acre which would be susceptible to damage by hail should it occur during the growing season. Apples, cherries, and other tree fruits in Washington and Oregon, oranges, grapes, and other fruit crops and vegetables in California would seem to bear great risk of loss, but actually the damage resulting from the apparently high hail frequency there is negligible. Reasons for this are as follows: (1) Hail occurs in winter, when crops are less extensively grown. (2) Hailstones are usually too small to cause damage. (3) Part of the so-called hail is actually graupel or snow pellets which do little damage because of their softness.

Hailstones are not a major climatic hazard in other regions of the country. Two causal factors may be set forth: (1) Infrequency of destructive hailstorms and (2) smaller acreages of agricultural crops. In the Rocky Mountains, Great Basin, and Colorado Plateau Regions losses are small, due largely to the paucity of crops. In the Deep South and on the Piedmont and Coastal Plains of the Southeast occasional storms bring severe local damages to cotton, tobacco, fruit, and vegetable crops (Figures 5 and 6). In Florida fruit, vegetables, and greenhouses are sometimes destroyed as far south as Lake Okeechobee, as was true in March of 1940. A record for North Carolina for the years 1913–38, submitted by G. C. Merchant, Official in Charge of the Weather Bureau Office at Columbia, shows state losses of nearly a million dollars in 1914 and 1937, a total loss of $4,356,880 for the period, and an average annual loss of nearly $170,000. The average loss is not impressive, but some producers bear heavy hardships in years of bad loss, somewhat offsetting years of grace. In 1922, for example, hailstones "large enough to split watermelons" fell near Concord, North Carolina. In many places the stones piled up to depths of a foot. Weather Bureau officials of various stations in Virginia say that hail is infrequent and usually of small size in that state but that at least one bad storm per year brings enormous destruction to the truck and tobacco fields of the Piedmont (Figure 6). This is probably the region of greatest damage within the state.

FIGURE 8.—Damage produced in this field of wheat by hail in July, 1932, illustrates the type of destruction to which widespread fields of wheat and other cereals are subject each growing season. This is especially true in the Great Plains and Central Lowland. (Courtesy of Western Hail and Adjustment Association.)

FIGURE 9.—The large, tender stalk and leaves of the corn plant are highly susceptible to injury by hailstones. The danger is greatest during the tasseling period. This field of corn was damaged by hail at Wayne, Nebraska, July, 1937, at four o'clock in the afternoon. (Courtesy of Western Hail and Adjustment Association.)

In the East and Northeast hail, in general, is a minor problem to agriculture and other industry when compared to such other natural hazards as lightning, windstorms, flood, and drought. Pennsylvania, however, has the rather impressive total of 19 damaging storms per growing season, although only seven of these are of the heavily damaging type. Southern and southeastern Pennsylvania receive most of this damage (Figure 2). Elsewhere, in local areas fruit, truck, and grain are damaged (Figure 12). The extensive tobacco area of the Connecticut River Valley has experienced a number of storms causing in excess of $1,000,000 each in damages. In 1924 a hailstorm unaccompanied by rain damaged more than 5,000 acres of tobacco and wrecked many

tobacco sheds. More than one-fourth of the members of the Connecticut Valley Tobacco Association asked for adjustments on their crops. In August of 1929 a series of devastating hailstorms accompanied a low pressure trough across several eastern states. At Plainfield, New Jersey, there were three storms during the afternoon. Hailstones "as large as pullet eggs" and "composed of five or more layers" wrought damage to property. In the Connecticut Valley, particularly on the east side of the river, hail fell for an hour and stripped tobacco fields. This series of storms was produced, according to Brooks (*Bull. Am. Meteoro. Soc.*, 1929) when: "Cold air aloft evidently ran some distance ahead of that at the surface, thereby providing the very steep lapse rates required for the production of the intense local thunderstorms."

ECONOMIC, SOCIAL AND POLITICAL SIGNIFICANCES OF HAIL DAMAGES

To the farmer of the Great Plains hail is a real climatic hazard. It is probably more significant to his economy than to that of any other major agricultural section. This is due in no small part to the one-crop agricultural system of the Plains—cotton in the south, wheat and corn in the central and north. All injure readily and extensively (Figures 8 and 9). They are

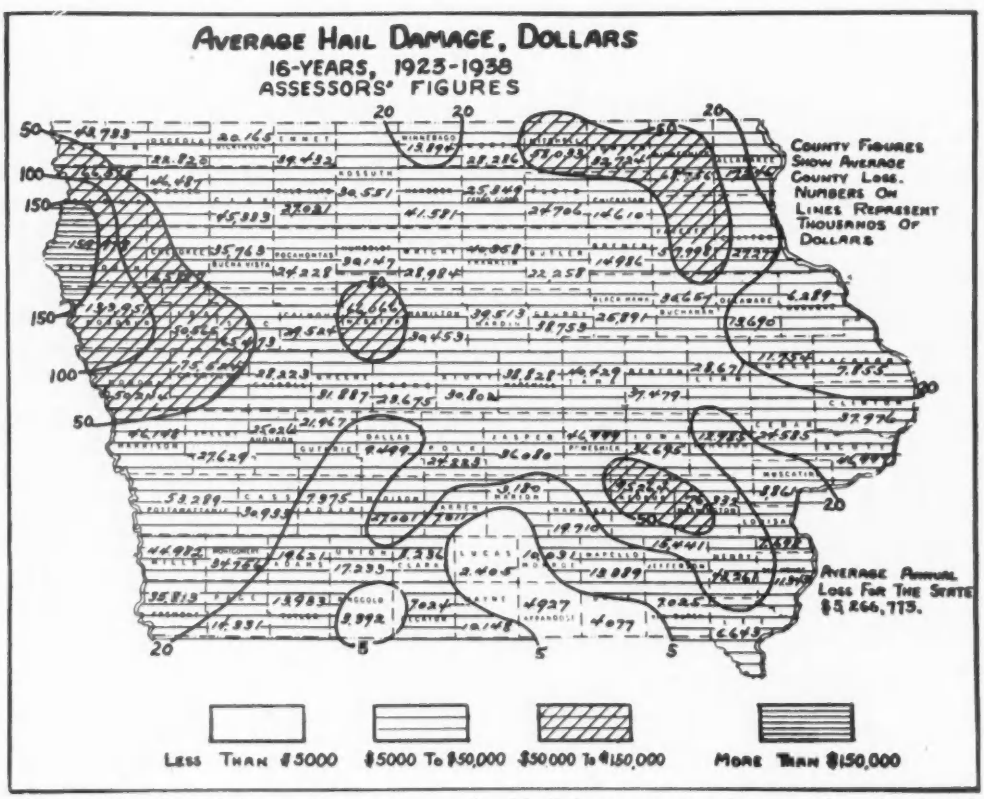

AVERAGE HAIL DAMAGE, DOLLARS
16-YEARS, 1923-1938
ASSESSORS' FIGURES
COUNTY FIGURES SHOW AVERAGE COUNTY LOSS. NUMBERS ON LINES REPRESENT THOUSANDS OF DOLLARS
AVERAGE ANNUAL LOSS FOR THE STATE $5,266,773.
LESS THAN $5000
$5000 TO $50,000
$50,000 TO $150,000
MORE THAN $150,000

FIGURE 10.—One of the most accurate records of hail damage to growing crops is maintained in Iowa. Mr. C. D. Deed of the Des Moines Weather Bureau Office cooperates with the State Department of Agriculture in analyzing and interpreting statistics gathered by assessors from agriculturists of the state. Average losses (based on a sixteen-year period) for counties and other type regions are here portrayed. Note the occurrence of "hail pockets" or areas of high average loss. Insurance rates are higher in these "hot spots." The northwest counties are most subject to damaging hail, while many central counties are almost immune.

grown where storms come often and stones come large. Thus, one local storm destroying a section of wheat, nullifies the farmer's income for the year, blasts his hopes and ambitions. Such an entrepreneur carries all of his economic eggs in one basket. His is not the diversified economy of the Central Lowland, where the shock of one hailed crop is absorbed by sale of another or of livestock. In the Plains, hail is among the farmers' worst natural enemies. Consequently, it is not surprising to recall the geographic locations of the six states which have tried, by establishing special hail insurance departments or hail funds, to cope in a political way with a meteorological problem. The objective has been the alleviation of social and economic difficulties ensuing from hail damage. All of these states, North Dakota, South Dakota, Nebraska, Oklahoma, Montana and Colorado, are located entirely or partially in the Great Plains.

FIGURE 12.—Most varieties of tender truck are easily injured by even light falls of hailstones. Damage is great each year to these localized crops, although it is small compared with that to the major crops. This figure shows tomato plants damaged by hail at Swedesboro, New Jersey. Hail damage occurs in every growing season in some parts of the trucking areas of the Atlantic and Gulf Coastal Plains. (Courtesy of Western Hail and Adjustment Association.)

FIGURE 11.—Over a four-year period hailstorms were three to five times more frequent in the leeward southeastern portion than in the windward northwestern section of the lower peninsula of Michigan. Seeley and Dale attribute a preventive influence to Lake Michigan. Most of the western area thus enjoys a marked advantage in this respect over the southeastern area in fruit growing as a result. (Courtesy of Seeley and Dale, published by *Monthly Weather Review*.)

Hailstorms, occurring as they do in unpredictable fashion, tend to make the life of the farmer a veritable "hand-to-mouth" existence in those many localities of frequent hail where agriculture is the principal means of support. Insect pests, plant diseases, and other evils which are also ever-present risks have been partially offset by scientific achievement through development of hardier and more disease-resistant plants or by methods of preventing insect invasions. Hailstorms, however, can by no means be prevented and only by few means can their effects be alleviated. In recent years there has been a greater tendency to insure against loss from hail, but the very unpredictory nature of the hailstorm tends to lull the farmer into a false sense of security, thinking that his chance of being hailed is not worth the added production expense of insuring. To those who fail to insure and subsequently have their crops virtually destroyed by hail the loss is

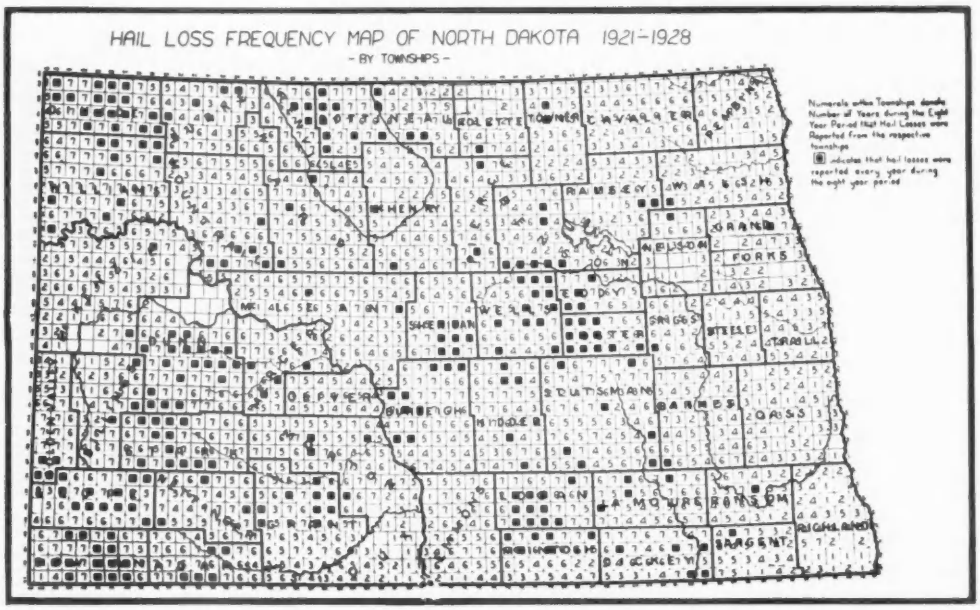


FIGURE 13.—The state of North Dakota maintains an accurate record of occurrence of damaging hailstorms to growing crops through its Hail Insurance Department. Most of the coverage in the state is carried by the State Department due to the low rates and to the fact that the program is partially tax supported, all agricultural land being assessed a minimum fee whether the owner carries the insurance or not. As illustrated, there are several hail pockets in the state where damaging hail occurred in all years during an eight-year interval. Practically all townships experienced damaging hail in more than fifty per cent of the years. (Courtesy of North Dakota State Department of Hail Insurance.)

usually directly and distinctly felt, necessitating a lean year of living while waiting for another season to recoup the loss—a year in which many luxuries and pleasures must be foregone and perhaps some necessities omitted. Should the victim of the loss be a sharecropper or tenant farmer, great deprivation may be a direct result, ending in malnutrition, undernourishment, and general health-deterioration.

The effects of the loss do not end in the direct loss and suffering imposed on the farmer, but extend indirectly beyond into urban areas as well. Economists sometimes agree that agriculture is the backbone of the nation and that the welfare of the nation in large measure depends upon the well-being of this raw-material-producing contingent. When large percentages of the total annual wheat, corn, fruit, and cotton crops are rendered valueless as a result of hail, the diminished purchasing power of the growers is felt by those who normally supply feeds, seed, machinery, food, household supplies and other items to the farmer. Such conjecture is not making mountains of molehills. Specific examples of multi-million dollar losses in a single state in a year, and averages of many millions for the country as a whole cannot be idly brushed aside. The initial loss of buying power permeates the whole economic and industrial structure of the nation, perhaps decreasing employment and curtailing production in many lines. Economically and socially, hail damage is significant in that it means less money to the farmer, and less food and higher prices to the consumer.

Hail has been significant, politically,

for centuries. C. F. Talman, in one of his books, even maintains that the French Revolution was hastened by a severe hailstorm of 1788 which enhanced popular discontent in France.

At present in the United States, political significance is shown by the existence of hail departments in several states and by the attention which is given to hail in the federal crop insurance program. The implications of hail damage, when taken in total view, reveal a situation demanding remedial action, not alone for the welfare of the agricultural group but for the good of the nation as a whole. It is no wonder, then, that numerous devices and institutions have been proposed for coping with the problem.

COPING WITH THE HAIL PROBLEM

European governments for centuries have sought means of preventing hail occurrence and of lessening damages which it brings. Various devices ranging from black magic to such mechanical contrivances as "niagaras," and cannon, which are supposed, respectively, to break up the storm by drawing off the electrical charge and to disrupt the convectional whirl by detonation, have been used. That they are still seriously considered by some men is indicated in an article by a Frenchman, Col. F. Ruby, "Nouvelles Etudie sur la grêle," which appeared in 1938 in *Review de Geographie Regionale*. Col. Ruby suggests that multitudes of high-powered bombs be dropped from airplanes into the cumulonimbus hail clouds. There is general agreement among scientists at present, however, that no mechanical apparatus nor other device has any power of prevention or alleviation of hailstorms. The tremendous forces of the atmosphere which are involved in the genesis of a

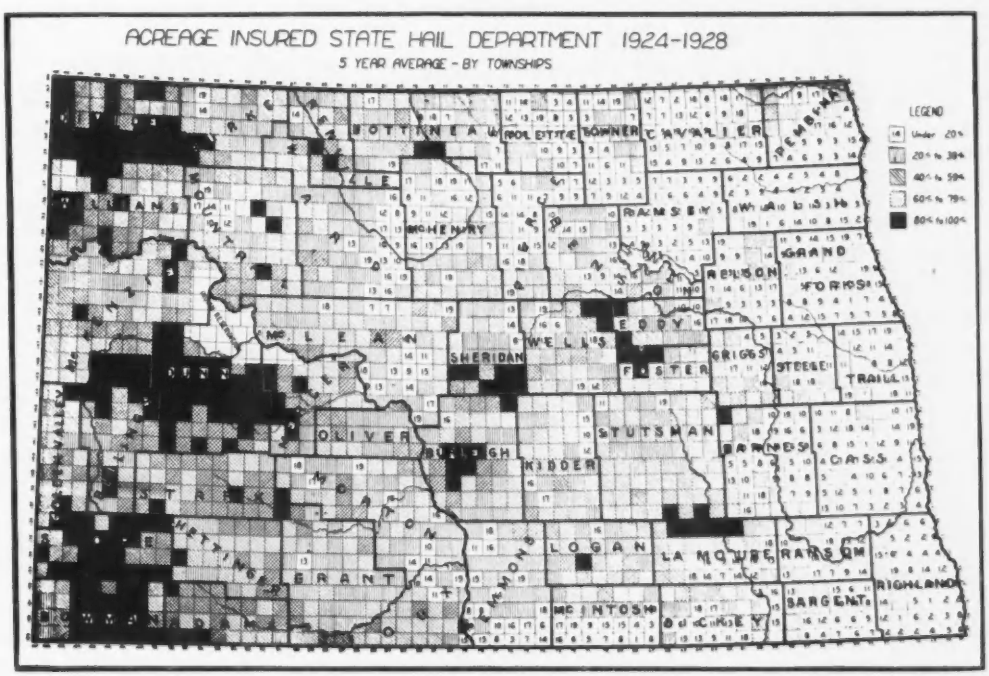


FIGURE 14.—Average township acreages of crops insured with the North Dakota State Hail Insurance Department over a five-year period. Note (1) that, in general, two-thirds or more of the acreage was insured from the central area to the western boundary; (2) that coverage was light in the extreme eastern region; and (3) that the amount of coverage varied directly with frequency of storms as shown in Figures 13 and 15. (Courtesy of North Dakota State Department of Hail Insurance.)

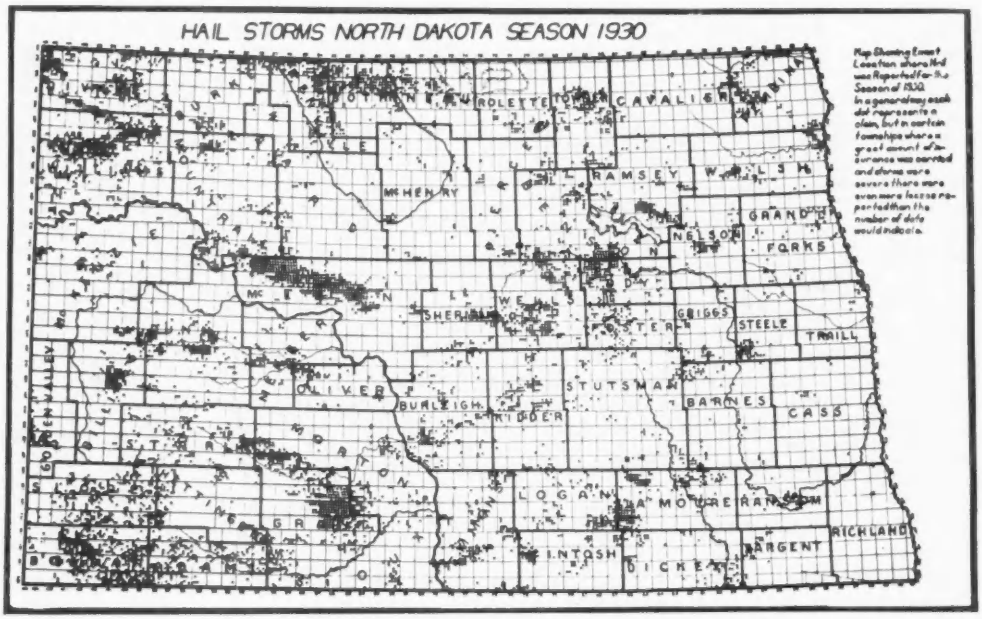


FIGURE 15.—Locations of crop-damaging hailstorms by townships for 1930. By comparing this figure with Figures 13 and 14 it is apparent that hail losses and coverage against losses by hail vary with regional frequency of damaging storms. (Courtesy of North Dakota State Department of Hail Insurance.)

common hailstorm are beyond the scope of human control. The only successful method of coping with this deleterious climatic phenomenon is hail insurance. Insurance does not attempt to disrupt the hailstorm or even prevent the fall of hail.

There are three chief types of insuring agencies: (1) mutual companies, (2) joint stock companies, and (3) governmental departments. Each has its virtues and its weaknesses, but in general, all perform valuable social functions. They do not negate nor obviate loss caused by hailstorms. They are based, rather on the principle of group coöperation and their objective is alleviation of loss effects through distribution of loss among the many individuals of a group.

At the present time, a large volume of hail insurance is written each year. As far back as 1919 N. A. Olsen estimated that more than a half billion dollars of such insurance was in force. Four-fifths of it was written in the central and northern Great Plains states and Iowa, while more than half was written in the states of Kansas, North Dakota, and Iowa alone.

K. A. Wagner pointed out in 1933 that half of the gross premium income of all state mutual insurance associations insuring against tornadoes, windstorm, fire, hail, etc., came from hail insurance. Losses paid for hail damages amounted to more than half of the total for all of this insurance. Wagner pointed out, further, that insurance experience shows that the "insurable chance for loss" for farmers in Iowa is one in six chances to have growing crops damaged by hail, but only one in two hundred to have buildings damaged by wind or tornadoes.

In spite of the impressive volume of insurance which is carried by farmers, it is apparent that other thousands of acres of crops go unprotected. Flora says that "it is known that a very large per cent of hail losses in Kansas

are not covered by insurance." Wagner estimates that only one-fourth to one-third of the farmers of Iowa carry hail insurance.

In those regions in which hailstorms come practically every growing season, it would appear that they rank with

FIGURE 16.—Fruit is easily bruised by hailstones. Such bruises may lower the marketable price of the product, as was true of these Idaho apples which were injured by hail in June, 1936. (Courtesy of Western Hail and Adjustment Association.)

the more formidable climatic hazards. In North Dakota most townships suffer hail losses more than fifty per cent of the time, while townships in certain "hailpockets" experience losses each summer (Figure 13). That there is a rough ratio between frequency and amount of hail loss and acreage insured is illustrated by a comparison of Figures 13, 14, and 15.

Successful crop hail insurance is based on two principles: (1) Complete statistical information. (2) Scientific knowledge of plant physiology as related to damage by hail. Plant physiology has direct bearing on adjustment of losses. Experiments by Dungan, Eldredge, Franzke, Hume, Loomis et al, in which plants were artificially injured in simulation of hail injury, show two important results: (1) Plants vary in their susceptibilities to hail damage. (2) Plants differ at various stages of growth in their susceptibilities to damage by hail.

REACTIONS OF CROPPED PLANTS TO HAIL INJURY

Hail inflicts two types of injury on growing plants: (1) Leaf injury. (2) Injury to stalk, branches, or fruit. Of the cereals, wheat, in general, is most resistant to damage from hail. Corn, oats, and buckwheat, however, are extremely susceptible to injury (Figures 8 and 9). Leguminous plants receive injuries most frequently in the nature of bruises. Flax, hemp, cotton, and other textile plants are easily and extensively injured by hailstorms. Tobacco, because of the wide expanse of its tender leaves which are the commercial product of the plant, injures easily and extensively (Figure 6). Damage to fruit crops varies widely according to the violence of the storm, stage of maturity of the crop, and the nature

FIGURE 17.—Although hail damage to fruit is small compared with that to cereals, local fruit crops are partially and totally destroyed in many parts of the country. A more severe type of injury, that to the fruit trees themselves, also occurs commonly. This is a view of Idaho peaches injured by hail in June, 1936. (Courtesy of Western Hail and Adjustment Association.)

of the fruit itself; but at any time after the buds appear on fruit trees, serious injury may result from even light falls of hailstones (Figures 16 and 17). Experiments on artificially injured corn show an almost direct correlation between time of season, stage of maturity of the plant, and amount of defoliation

on the one hand, and loss in yield on the other hand. The extent of loss to corn from hail bruises on the stalks depends on the stage of maturity of the plants, but, in general, is greatest at the critical, tasseling period. Damage from stalk bruises is less serious than defoliation. Bruising of ears is most serious during the milk and pollination stages, but, generally speaking, causes less damage than either defoliation or stalk bruising. Injured corn may be retarded in growth to such an extent that it becomes subject to the frost hazard. Wheat, barley, and rye react similarly to injury. Damage in the earlier stages is usually light unless severe storms occur. Near maturity, susceptibility is great.

The nature of the weather immediately following hail injury has great effects on eventual recovery of a crop. Favorable weather may induce rapid rejuvenation; unfavorable weather may encourage diseases and insects or retard growth and maturity until the frost period. In 1921, for instance, a forest of loblolly pine in North Carolina was severely damaged by hail. The weakened trees were later subjected to an attack by beetles and great havoc resulted. (Holmes, J. S., *Monthly Weather Review*, 1921.)

CONCLUSIONS

Due to a combination of geographical and climatological factors, hailstorms exert considerable influence on economic, social, and political conditions in many parts of the United States. This climatological phenomenon is especially significant in the Great Plains and Central Lowlands where the nation's most extensive farming lands are situated, where hailstorms come in maximum frequency, and where the time of maximum frequency of hailstorms coincides with the times of growth and maturity of the principal crops.

Hailstorms cannot be prevented, nor can their devastating forces be mitigated. Only by group participation in sharing losses can their effects on the individual be alleviated. Only by careful analysis of time-areal hailstorm distribution over long periods of time and by careful study of the reactions of plants to hail injury, can the menace of hail be successfully met.

CHANGES IN LAND UTILIZATION ON THE PLATEAU OF NORTHWESTERN COLORADO

Charles M. Davis

THE history of settlement of the dry margin lands along the western slope of the Rocky Mountains in Colorado is marked by well defined periods each of which began with the addition of some new factor to the economy of the district and ended, ordinarily, with a catastrophe resulting from misuse or maladjustment to the productive capacity of the soil. Evolution of land utilization through trial and error is the costly and common course in those places where the greatest amount of regulation and planning seems called for. The plateau country is one of these.

The area in northwestern Colorado represented on Figure 1 is composed of two districts. The first is a mountainous area, a section of the northern end of the southern Rockies. The second is a plateau district formed by the northern part of the Colorado Plateau and a southern extension of the Wyoming Basin. The two districts, mountainous and plateau, present more physiographic differences than they do likenesses, but there is a great deal of similarity in the history of land settlement and the course of land acquisition within them. The similarities of settlement can be attributed to the fact that a common land type, grassy sagebrush mesas, induced a grazing economy which has always been the basic form of land utilization. The geography and settlement of the two principal mountain basins, North and Middle Parks, has been described in earlier articles on northwestern Colorado in ECONOMIC GEOGRAPHY, and are omitted from this analysis except for purposes of comparison.

The mountainous eastern part of the area shown on Figure 1 is essentially a frame of high ranges enclosing open areas of sagebrush mesas, called "parks." The ranges themselves form one of the chief land types; high rugged mountains, covered with a growth of coniferous timber. The foothills are more open and contain groves of aspens along with grassy and brushy intervales of considerable value in the ranching operations as summer pastures. Into the park floors streams have cut valleys, either wide and shallow or narrow and deep. The valley bottoms and some of the adjoining terraces have been irrigated to such extent as the characteristics of the surface and the water supply will permit. This irrigated hay land is the essential type for the ranching economy.

The western slopes of the Park Range, occupying most of eastern Routt County, resemble in general those of the other ranges with one important difference: being west facing, they receive more rainfall. The park floors to the east of the ranges lie in rain shadows which reduce the precipitation to ten or twelve inches whereas the western piedmont, in particular the mountain pocket west of Steamboat Springs has an annual average of more than twenty inches. This fact in the later days, led to the establishment of an agricultural population on the plateau and a consequent complication of the course of land history.

The second of the two divisions of northwestern Colorado, the plateau district, extends from the piedmont of the Park Range and its outlying volcanic

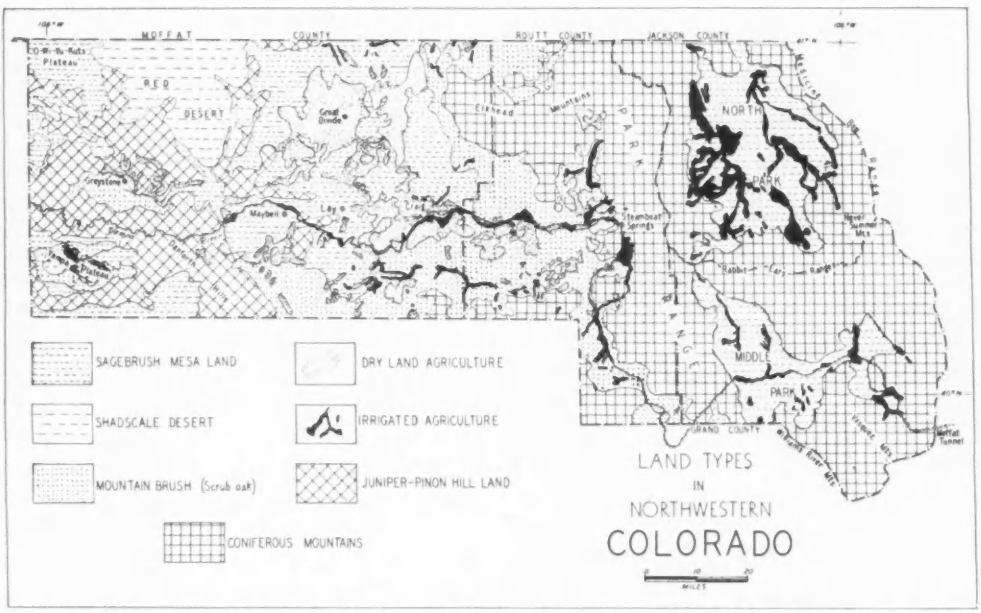


FIGURE 1.—The eastern part of the map represents the mountain district, the western part, the plateau district. The most successful dry farming areas are those along the western piedmont of the Park Range. (Adapted from maps of the Geological Survey.)

attachment, the Elkhead Mountains, westward to the Uinta Mountains in Utah. It contains less relief than the mountain district but possesses a greater variety of land types and a much more intricate arrangement of these.

The most important land type of the plateau is a broad expanse of sagebrush covered tableland occupying the central and eastern part of Moffat County. Similar smaller detached areas appear on the Yampa and O-Wi-Yu-Kuts plateaus. From the town of Craig westward to the Danforth hills the tableland is cut deeply by the Yampa River and tributary dissection has reduced the upland to a succession of smaller mesas. The northern part, around the town of Great Divide, is characterized by broad smooth surfaces and relatively gentle slopes; in this vicinity dry land agriculture became established in its widest extent. Western dry farmers believe that sagebrush growth indicates "sweet" soil and moisture holding capacity; the fact that most of the dry grain farming in the plateau is located on sagebrush land is an indication of the validity of this assumption. The sagebrush land type of the plateau is essentially similar to that of the mountain parks. The rainfall differences between the two are critical to agriculture but do not differentiate the natural vegetation.

Lying next to the sagebrush type and surrounding it on three sides is the mountain brush. This vegetation occupies the lower foothills of the Park Range, the Danforth Hills, and a connecting mountainous area extending south of the Moffat County boundary and beyond the limits of Figure 1. The vegetation cover is composed principally of scrub oak brush and also contains some sagebrush from the lower flat lands as well as aspens and coniferous trees from the higher foothills above. The mountain brush type is distinctly a hilly rather than a flat land association and the roughness of the surface has made it impractical for agricultural

settlement. The areas of dry farming shown on Figure 1 from Craig to Steamboat Springs are actually established on sagebrush lowlands along the Yampa River rather than on the mountain brush type itself.

The two remaining land types which make up the western part of the plateau district are important to settlement only in a negative way. The juniper covered Danforth Hills and the plateau edges are too rough and arid for general cultivation. At one place, along the valley of Cottonwood Creek, the local conditions of slope and seepage together with hope and misplaced optimism established the Greystone settlement. The last of the land types, the Red Desert, is a projection into Colorado of the Waskakie Basin of Wyoming. The shadscale vegetation which differentiates this type from the sagebrush uplands probably results from edaphic aridity coupled with alkaline "sourness." The desert country has no siren appeal; not even the most hopeful settlers have plowed its surface.

OPEN GRAZING

The cattle ranges west of the mountains are open both from the south and the north and were entered for grazing earlier than the more inaccessible parks. There are no major obstacles to cattle drovers from either direction. Trail herds from Texas were brought into the plateau soon after 1870 to fatten on the plentiful grass before being shipped to eastern markets. This was a seasonal utilization and the cattle were not kept in the plateau over the winter. Until the range began to be crowded, there were very few permanent ranching establishments and almost no land acquisition.

Throughout the decade of the 1880's the cattle business was expanding under the impetus of large markets, high prices, and free grass. Unlimited capital seemed to be available from the east; the plains of Texas produced countless herds to stock the northern ranges; the only limiting factor in this happy combination was the extent of the grass. Between 1870 and 1882 the number of cattle in the west increased from five hundred thousand to the amazing total of thirty million. The belt of steppe country along the eastern Rocky Mountain front was trailed over and grazed over. More inaccessible areas such as the plateau and mountain parks became increasingly valuable as the older ranges were exhausted. Cattlemen would drive their herds almost any distance to good grasslands; would fight to protect their right to use them; would do almost anything, in fact, except to purchase the land.

There was no immediate reason why the cattlemen should acquire all of the land they use in their operations. It certainly is true today that a large part of the range contains so little forage as to be unprofitable under private ownership and has stood open for sale these seventy years at the minimum government land prices without purchasers. Yet the annual growth, little as it may be, should be utilized in some manner. Under the provisions of the Taylor Grazing Act of 1934 these submarginal lands were removed from their open status and made available for cattlemen to the extent the condition of the ranges permitted and at rental fees in keeping with their forage values. In effect this permits the regulated use of lands which do not produce enough to pay taxes. The difficulty with the open grazing system was not that low value lands were used, but that they were overused and populations both of animals and humans were built up beyond the capacity of the land to sustain them for long periods. In a

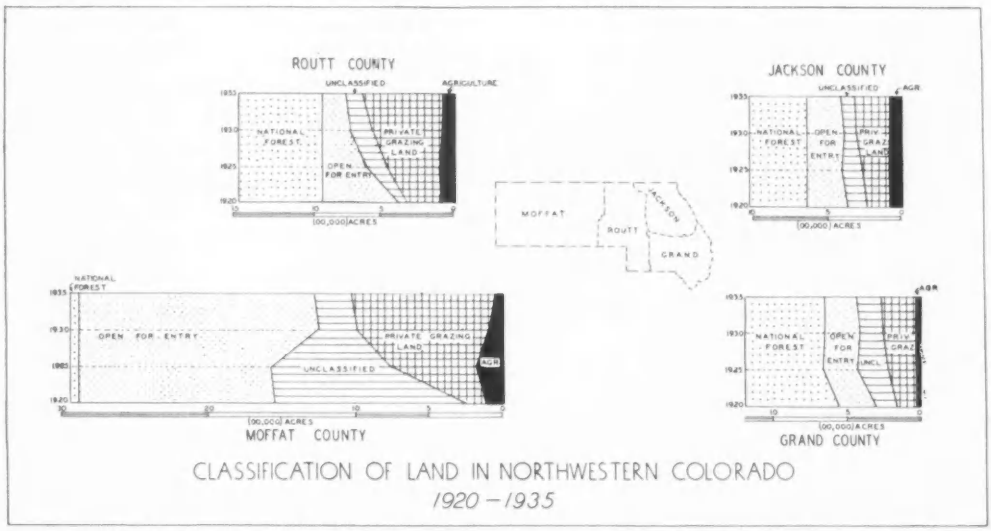


FIGURE 2.—Jackson and Grand Counties represent mountain basins; Moffat County, the plateau. Routt County contains elements of both. The permanency of agriculture in the mountains forms a contrast with its decline in the plateau.

rough way the cattlemen controlled the range they used by acquiring the available sources of water. Before the days of drilled wells and of windmill pumps, cattle were confined to the area within which they could graze and return to water. Whoever owned and fenced the streamsides and the water holes controlled the upland pastures. Judicious acquisition of valley land was the basis of most of the great cattle companies along the eastern Rocky Mountain piedmont. Some of this was purchased from the state or national governments and some from the railroads. Much was acquired by homesteading under the Act of 1862 which limited acquisition to one hundred sixty acres. Owners, cowboys, relatives, friends, and many entirely fictitious persons filed claims to protect the water frontage on large ranches.

In the plateau and mountain districts the stream bottom lands had additional significance for they were the only places where cattle could find enough food and shelter to survive the winter without heavy losses. By simple irrigation systems the valley flats could be improved into hay fields permitting much greater numbers of cattle to be carried over the winter. The first ranches in the plateau were located along the wider parts of the Yampa River valley between the towns of Steamboat Springs and Craig and the first type of land to come into private ownership was the irrigable streamside.

By 1890 the open grazing period in the plateau had reached its peak and was declining rapidly. The upland range was so badly overgrazed that most of it has never since been capable of supporting large herds or of paying minimum taxes. Under the steady private acquisition of streamland the range became of little use to the landless and indigent trail herders and was left by default to the control of the established ranches along the streams. Stock raising ceased to be an adventure and became a business; lost its nomadism and became attached closely to the meadows. There was a relatively small amount of this type of land available in the plateau as compared with the mountain parks and it did not so effectively control all of the upland range.

Large areas in the western and northern parts of Moffat County contained no valley land capable of easy irrigation but nevertheless had much upland pasture of mediocre quality. In these parts of the plateau open grazing continued; dwindling both in extent and in returns as the depleted ranges steadily lost their capacity to support cattle.

RANCHING PERIOD

Following the peak of open grazing in about 1890 the established ranchers both in the parks and in the plateau settled down for a quarter of a century of development. The earlier grazing years had been an exploitive scramble for free grass without any consideration of the long-time ability of any of the land types to support the economy. The ranching period from 1890 until 1916 was a slower growth with full recognition of the environmental factors which underlay the operations.

It had become apparent in the period of open grazing that winter feeding was necessary to successful ranching. Consequently the acquisition and development of meadow land almost to the exclusion of the upland was the distinguishing activity in the land history until 1910. Although the meadows were extremely important they were small in extent. In 1900 less than five per cent of the area of Moffat County had passed into private ownership and by 1910 this had been increased to only eight per cent. Irrigated land constituted the principal agricultural type, approximately two-thirds of the improved acreage was used for this purpose. The increase in cultivated forage took a heavy burden from the ranges on the other land types. The mesas and foothills could support larger numbers of cattle if used for shorter periods in the spring, summer, and fall. The amount of stock in the plateau increased slowly from the figure to which it had fallen at the end of the open grazing years; the increase being in almost exact ratio to that of the irrigated acreage. As the amount of natural range forage remained constant, or actually decreased from overgrazing, the two complementary components of the ranching economy approached a balance. At some period between 1910 and 1915 the number of cattle that could be supported through the winter exceeded the capacity of the summer ranges and a serious shortage of upland range was in prospect.

FIGURE 3.—Typical situation of land types in the plateau district: sagebrush flats between the base of the hills and the river bottoms.

FIGURE 4.—Desert country, typical of that in the Red Desert area of northwestern Moffat County. The uplands bear a scadshale cover but are useless for agriculture.

There was, however, no attempt to acquire any large amount of the natural pasture land. Much of the range was so depleted that it was not worth owning and, as explained in the earlier descriptions of the park country, could be used without ownership. The cattlemen, among themselves, observed the limits of their respective control and even erected fences across the public land to mark this quasi-ownership. Sheepherders from the Wyoming basin were barred from the range, at first by "persuasion" of the Colt and Winchester variety and later by agreements which permitted them to use the higher slopes of the Park Range, considered useless as cattle pastures. To this point in its development the land history of the plateau district had not differed essentially from the concurrent development in the parks; a new factor, however, was to enter into scheme of things and differentiate the course of settlement in these two areas. Homesteading as a method of introducing new elements into northwestern Colorado, failed in the parks but took root in the plateau.

DRY FARMING YEARS

In 1908, the Denver and Salt Lake railroad which had been laboriously building its way through the multiple ranges of the Rockies reached Steamboat Springs. In 1909 Congress passed the Enlarged Homestead Act permitting the allotment of 320 acres and a shortened period of occupancy. These two conditions brought dry farmers into the plateau district. Agriculture was at first limited by railroad connections to the area within the Steamboat Springs pocket where an annual rainfall of more than twenty inches is received regularly. The yields of wheat, oats, and barley on the sagebrush flats of the valleys astonished the homesteaders and dismayed the ranchers.

The excellent situations for dry crops in the Steamboat Springs pocket are limited in extent. The Atwoods, in their study of land utilization in the Park Range, pointed out that the dry crops occupy the "low, flat-topped terraces" along Elk River immediately north and west of Steamboat Springs. Similar and larger flats are occupied by the dry farming areas south of the railroad between Steamboat Springs and Craig. Most of the pocket area, however, is covered by the mountain brush vegetation on land which is generally too rough for agriculture. Out beyond the piedmont and on the plateau proper were almost endless tracts of smooth sagebrush flat land, almost identical in appearance with the foothill terraces; "sweet" land; awaiting settlement.

Several causes combined in the next decade to produce a wave of dry land homesteaders on the plateau. In 1913 the railroad was extended to the town of Craig giving access to the area farther west. Denver newspapers and land speculators had given wide publicity to the agricultural possibilities of Moffat County. At the same time the rainfall, following the characteristic fluctuations of dry margin precipitation, had been unusually heavy; accounting in part for the high yields on the Routt County farms. On a war market the world price of wheat rose from eighty cents in 1915 to two dollars and over in 1919. To complete this attractive picture, the Stock Raising Homestead Act became a law in 1916, offering a full section of 640 acres to promote combined ranching and farming operations.

The dry farming areas developed along the south side of the Yampa River as the railroad was built westward, occupying almost all of the suitable flats within the zone of plentiful rainfall and extending out into the plateau district west of Craig. Immediately after the close of the war, in 1918, there was a rapid and widespread extension of homesteading. The following figures from the *Colorado Yearbook* indicate the magnitude of this settlement in Moffat County:

	*Total Farms**	*Owners*	*Homesteaders*
1920.....	891	702	97
1922.....	1910	956	815
1923.....	2195	1359	707
1924.....	2367	1692	538

*Includes renters and owner-renters.

The full section allotment to each homesteader permitted a wide areal extension and a consequent dissemination of the homestead farms. The agricultural areas represented on Figure 1 should not be thought of as expanses of cultivated fields; each farm contained, ordinarily, from fifty to one hundred and fifty acres of plowed land; the balance, three-quarters or more of the farm was sagebrush range land closed off by fences.

Wheat was the crop which promised the quickest returns and occupied most of the crop land. There was always a market for wheat and almost always a crop although the fluctuations in the rainfall produced astounding variations in the yield. Between 1919 and 1921, for example, the yield changed from

FIGURE 5.—Sagebrush flat land extending up into a mountain valley. Many such small homestead sites occur in the piedmont slopes.

seven to sixteen bushels per acre while the price dropped from two dollars to a subnormal seventy-five cents. Under such conditions and upon land which had not been worth owning as cattle range was expended the cost of a house, fencing, wells, tools, and seed.

The largest homestead area developed north and west of the railhead at Craig where there were relatively continuous extents of smooth mesa land. Smaller centers at Greystone and south of Maybell were large enough to be called secondary farming districts. In many small pockets and streamside flats close up against the base of the hills a single homesteader, or perhaps two families, found a section on which to begin agriculture. Some of these situations were equal to the best land in the Steamboat Springs pocket but there was little of it in any single place. This disseminated population carried with it the inevitable difficulties of roads, schools, and other public services which are common to areas of interspersed marginal and sub-marginal land.

The homestead tide reached its height in 1924 and its ebb was almost as sweeping as its flow. Much of the agriculture was marginal even under high crop prices and the most favorable periods of the rainfall cycle. The cost of improvements in labor and capital had resulted in land values far in excess of the productive capacity of the soil. The inevitable drop in rainfall and prices broke the homestead wave and washed away much of the settlement it had established. Compare the following statistics with those above:

	Total Farms	*Owners*	*Homesteaders*
1928	720	520	62
1929	714	544	46
1930	797	525	53
1931	700	545	42

The county assessor reported the following dry crop acreage for the county:

	Acres
1914	4,936
1920	79,808
1925	130,879
1928	40,974
1929	39,112
1930	35,237

Some of the broken homesteaders abandoned their claims and moved away. From 1924 until 1930 the county as a whole lost approximately 400 persons from its population but many stayed on hoping for another period of high yields and high prices which never arrived. In 1929, at the peak of prosperity in the country as a whole, one-half of the agricultural land in the county was delinquent for taxes and by 1932 this had become seventy-five per cent.

The homestead period made extensive changes in the pattern of ownership. A large proportion of the best range had been removed from the public domain, transferred to private ownership and then abandoned. In default of taxes it became the property of the county and either sold or leased to ranchers who had been using it before the homestead days. The long time effects of misguided cultivation on the land itself have been disastrous. The old wheat furrows produced more weeds than forage plants and the loose soil, stripped of its cover, was washed and blown until critical erosion is reported to be "the rule" in the homestead districts by the investigators of the Forestry Service. A report made by the state land specialist of the Resettlement Administration in 1936 characterized the Great Divide settlement as follows: "May we state here that even more harsh words might have been

FIGURE 6.—A small ranch along the river bottom. Notice the stacked hay in the meadow and the brush and trees along stream; in such sheltered situations the cattle are able to live through the winter without heavy losses.

used in describing this settlement and use of land as a crime to society."

THE LAND SINCE HOMESTEADING

Figure 2 represents in a graphic way the general change in land ownership during and after the homestead period in the four counties which comprise northwestern Colorado. In these diagrams, the designation "unclassified" represents a category into which the county assessors place land of varying status; homesteads; state land purchased but not paid for, and public land withdrawn from entry. An analysis of these figures indicates the difference between land ownership in the mountains and on the plateau.

The two park counties, Grand and Jackson, have been little affected by the homestead period in comparison with its results in Moffat County on the plateau. The agriculture in the mountain parks of these two counties consists almost solely of irrigated hay production, an integral part of the ranching operations. This had reached its maximum development before the period of the homesteaders. The steady increase in private grazing land at the expense of the open and unclassified categories represents the actions of the successful ranchers in these parks in purchasing the better of the ranges they use in their operations. The significant decrease in the amount of National Forest land in Routt County between 1920 and 1925 resulted from a revision of the forest boundaries to release some of the foothill area.

The Routt County chart resembles in general those of the park counties. The open land, representing the open range, has been steadily diminished in direct proportion to the increase of private grazing land. The implication of this is that the pasture land along the western piedmont is worth owning if it cannot be used without owning. The unclassified category, which persists and even increases, is more difficult to explain. Some of it, probably, represents land acquired by the county by way of tax delinquency and now leased, rather than sold outright, to ranchers. The slight decrease in the agricultural acreage since the peak of homesteading in 1925 shows that Routt County did not entirely escape abandonment.

In Moffat County the drawing summarizes the story told above. The western part of the county, comprising half of the land, has always been open for entry, and apparently still is open,

subject to the provisions of the Taylor Grazing Act. The rise and decline of homesteading can be measured by the variations in the "unclassified" and the shrinkage in the agricultural land. It is apparent that approximately half of the abandoned homesteads reverted to open land and most of the remainder into private grazing land with the exception of some apparently retained by the county and leased to stockmen.

The problems which were left to the plateau by the homestead years; a stranded population, closed banks, heavy relief burdens, and ruined land are common to ill advised and uncontrolled agricultural pioneering on the dry margins. Lewis Mumford expressed the thoughts of students of marginal settlements when he wrote: "The pioneers who turned their backs on a civilized way of life in order to extend the boundaries of civilization, left us with a heavy burden—not merely blasted and disorderly landscapes, but the habit of tolerating blasted and disorderly landscapes."

FAIRS OF ELIZABETHAN ENGLAND

Margaret T. Hodgen

BEFORE commercial enterprise assumed its modern stationary and continuous character, internal trade in Europe was carried on intermittently at periodical fairs. The fair was in some respects similar to the market and grew up for similar reasons. Both were established by royal grants. Both, through the collection of tolls and other fees, were lucrative sources of revenue to their secular and ecclesiastical owners. Both arose under the influence of economic and environmental conditions which compelled the transit of goods to be slow and discouraged ordinary folk from frequent or long distance journeys. But the market was primarily a weekly assemblage of local traders organized to facilitate retail operations, whereas the fair often occurred but once a year and served the needs of wholesale as well as retail exchange. The market was intended to supply the short-time household needs of rural populations settled in restricted agricultural areas. The fairs ministered to the trade in luxuries, often brought from great distances. They were frequented by itinerant foreign merchants and large-scale buyers, as well as by all classes from noble to farm laborer, prelate to craftsman.

The importance of the fair as an expression of a universal stage of peripatetic, seasonal, or rhythmical commerce has long been recognized by students of economic history. They have accorded it exhaustive attention, focusing their researches upon its purported religious origin, its relation to the appearance of town life, its judicial aspects and its regulation of alien traders. Nevertheless, since historians, especially of English economic history, have been more interested in foreign trade than in the mechanism of internal exchange, little is known concerning commonplace facts such as fair locations, dates and duration; and still less of the relation of these facts to volume and content of trade, the condition of contemporary highways and the extent of long distance carriage of goods. Such lack of knowledge has led to the common acceptance of Harrison's comment on 16th century fairs as decadent (found in his *Description of England of 1577*), and the common assertion that after the 14th century the fairs of Britain dwindled in numbers and ceased to function as effective agencies of commercial exchange. There has been no effort, apart from occasional and more or less anecdotal references to prominent fairs, to describe the commercial system reflected in fair distribution or to indicate the areas served.

Under such circumstances, it is not the purpose of these pages to deal with all of the question which might be asked concerning English fairs. Bearing in mind, however, their assumed decline long before the 16th century, it is not without interest to note the evidences of their persistent vitality during the reign of Elizabeth. These appear in the atlases and road books of the period, and particularly in the almanacs. All of these publications testify to a vigorous demand for information concerning fair dates and locations, and the continuance of the need, two hundred years after their supposed deterioration, of this older form of commercial organization.

Of course, the almanac in its pre-

Elizabethan and earlier form was not intended for the use of the average buying and selling Englishman. It was compiled for students of astronomy, astrology, medicine, and law. To meet the needs of these scholars, it customarily contained merely an ecclesiastical calendar, a calendar of law terms and certain astronomical information; a chart of anatomical man surrounded with the governing signs of the zodiac; rules for blood-letting, purging, and bathing; a table of ebb and flood tides; weather predictions; and a prophesy or prognostication based upon astrological inference.

But in the later half of the 16th century, presumably in response to reader interest, almanac makers began to introduce new material. With the publication of Leonard Digges' *Prognostication Everlasting* in 1556, they expanded its content with the obvious intent of meeting the needs of a wider commercial public. As indicated in Thomas Hill's almanac of 1571 the publication became a reference book for business men, "a Booke of Memories, necessary for all such, as have occasion daylie to note sundry affayres, eyther for receytes, payments, or such lyke." In the almanac of Joachim Hubright in 1569, the traveler was given a list of roads, "a perfect direction of the best and rediest hyghwayes, from any notable town" with tables of distances from point to point. And "mente for all those who use the trade thereof," or for itinerant merchants and their customers, it included carefully compiled lists of the "principall Fayres of England and Wales, orderly set forth with moneth, day and place where they are kept."

Pocket-sized and selling for a penny, the little handbook, with this new and practical content, soon became the most widely read book in the language, sharing in small libraries a place beside the family Bible. Nearly every bookseller in London brought out at least one. And before the beginning of the 17th century, no less than six hundred, in an unknown number of editions, are said to have appeared. In short, the almanac in its new form not only testifies to widespread and continued interest in the places and dates of fairs during the later half of the 16th century; it also provides a legitimate and accessible means for determining some of the little known facts concerning their geographical and seasonal distribution at that period. More than this, however, they do not tell, and comment on the causes of the distribution must therefore remain largely suggestive and conjectural.

The fourteen Almanacs used for compiling the data were published between 1550 and 1600 and are to be found either in the British Museum or Bodleian Libraries. In the following list the Roman numeral indicates the item as described in Bosanquet's *English printed almanacs and prognostications*, (1917): CLXVII. Leonard Digges, *A Prognostication euerlasting* . . . (1556); LII. Henry Rocheforth, *An almanack and prognostication for this yere of our Lorde God M. DL. X.* . . . (1560); CLXXI. Leonard Digges, *A Prognostication euerlasting of right good effect* . . . (1564); CLXXII. . . . *Pronostycacion For euer of Erra Pater:* . . . (C. 1565); LXIX. Joachim Hubright, *An Almanacke & Prognostication* . . . (1569); LXX. Henry Low, *A new Almanacke & Prognostication* . . . (1569); LXXIII. T. H. (Thomas Hill), *An Almanack* . . . necessary for all such, as *haue occasion daylie to note sundry affayres, eyther for receytes, payments, or such lyke* . . . (1571); CLXXIX. Phillip Moore, *An Almanack and Prognostication* . . . (1573); LXXXIa. Alexander Mounslowe, *An*

Almanacke, and Prognostication . . . (1579); LXXXVII. Thomas Buckminster, *A new Almanacke and Prognostication* . . . (1584); XCVI. Walter Gray, *An Almanacke and Prognostication* . . . (1589); XCVII. John Harvey, *An Almanacke* . . . (1589); CVIII. Gabriel Frende, *A new Almanacke and Prognostication* . . . (1593); CXX. Robert Watson, *A new Almanacke and Prognostication* . . . (1598).

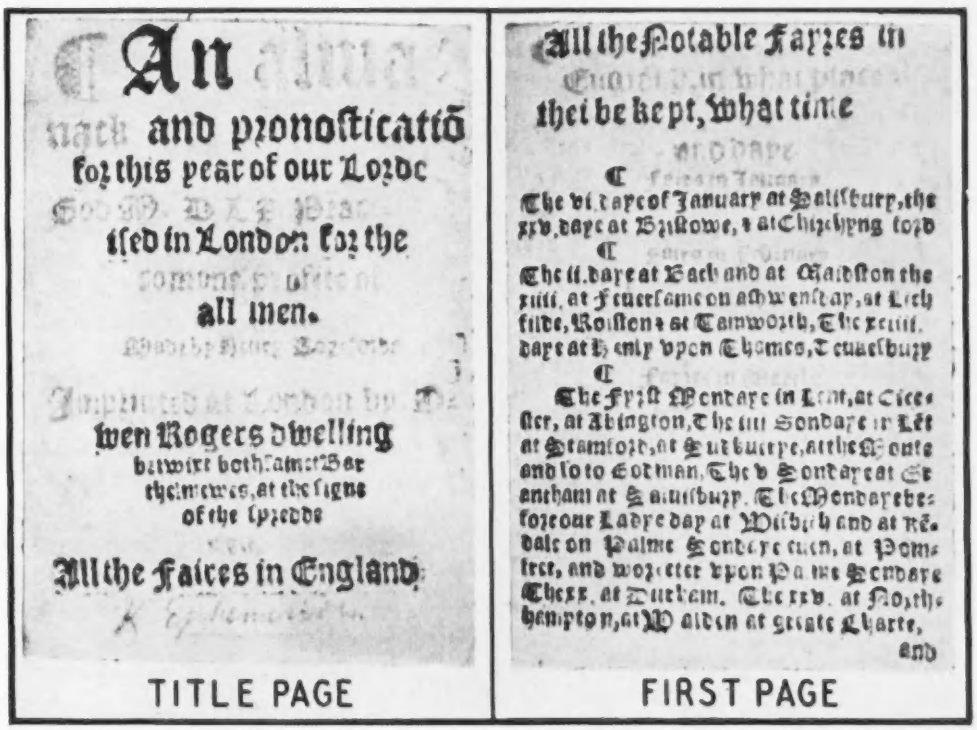


FIGURE 1.—Henry Rocheforth's *Almanack and Prognostication* published in 1560 and presenting a typical list of fairs in January, February, and March.

Geographical, Country and Regional Distribution. Britain in the time of Elizabeth lay on the circumference of European trade. It was a rural nation of some three and one-half million souls, and more than one-half of the country was a wilderness of heath and moor, hill and common. Nevertheless, this population, which was denser along the eastern coast and in the far western counties than in the interior, was served during the course of the year by no less than 996 fairs, of which 82 per cent, or 822 were in England, and 18 per cent, or 174, were in Wales. Since, however, many communities were the sites of more than one fair, sometimes indeed as many as six or seven, the number of fairs was almost twice the number of fair sites. There were only 545 towns or villages in which a fair was held in the course of the year. But of these, again, 82 per cent were in England, and 18 per cent in Wales (Table 1).

Owing to conditions for which the almanacs as such can give no explanation, internal trade, as governed by the location of fairs, was not evenly distributed over all sections of the country. If an inference may be hazarded from Figures 2, 3, and 5, the main stream of goods, in so far as it traversed county

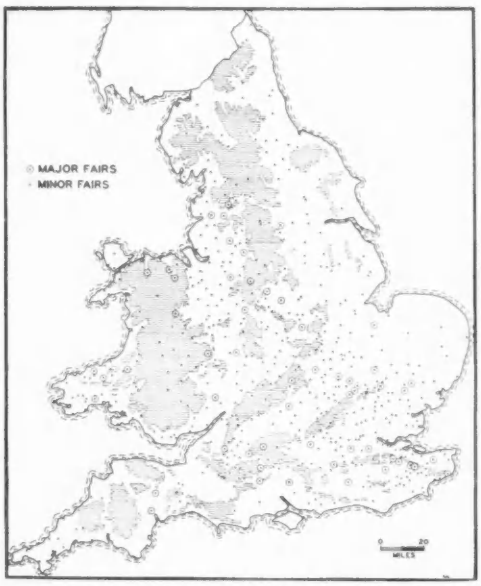


FIGURE 2.—General distribution of major and minor fairs in the sixteenth century, showing elevations and the division of England into two commercial regions.

lines, probably flowed along three "channels:" one between points in Somerset, Wiltshire, and Cambridgeshire or Derbyshire; another between Somerset, Wiltshire, and Kent; and a third between Kent, Essex, and Lancashire. These inter-county "channels" of trade are also suggested in the monthly fair distributions in Figure 4. In January the long-distance movement of goods, if it took place at all, occurred between such southwesterly fairs as Bristol and Salisbury and two northeasterly fairs in Derbyshire. In February, the Somerset-Wiltshire and Kent "channel" emerged; while in March the Kent-Lancashire "movement" is emphasized. It is plain also, judging by the densities of fair distribution and the groupings of sites of recurrent fairs (Figure 5) that the volume of trade was probably greater in England than in Wales, and in southern England than in northern England.

Judging again from similar data, there seem to have been two foci of buying and selling in southern England. One of these was in the coastal counties of Kent and Essex extending inland through Middlesex, Bedfordshire, Hertfordshire and Cambridgeshire. The important fair sites in this area were Dover, Canterbury, Lenham, Maidstone, Tonbridge, Malling in Kent; Bromley, Hedingham, and Saffron Walden in Essex; Hitchen, Baldock, and Ashwell in Hertfordshire; Biggleswade, Bedford, and Ampthill in Bedfordshire; and finally Cambridge. The other trading center appears to have been in Wiltshire with an extension over the border of that county into Somerset and Gloucestershire. The two coastal counties of Kent and Essex had 79 and 45 fairs respectively, or 12 per cent of all the fairs in England and Wales. The area including these two counties and Middlesex, Bedfordshire, Hertfordshire, and Cambridgeshire contained 212 fairs or 21 per cent of all fairs in England and Wales. In the Wiltshire cluster there were 47 fairs, many of which were in Salisbury, Marlborough, and Devizes. A third focus of trade in 107 fairs with many important fair towns also appears in northwestern England in the counties of Lancashire, Cheshire, and Staffordshire. Welsh trade seems to have centered in the counties of Carmarthen and Cardigan with 24 and 22 fairs respectively, as well as in the small county of Anglesey adjoining Cardigan. Many of the greater fair centers in England were concentrated within easy access to the English Channel, the Bristol Channel, and on the Cheshire Plain suggesting some relation between the situation of these sites and the distribution of overseas goods. The majority of the more important Welsh fairs were also on or near the coast. The counties having the fewest fairs were those in the far north, such as Cumberland, Westmoreland, Durham, and Northum-

berland; Devon and Dorset in the far west; some of the Welsh counties, and, strange to say, Norfolk in the east, which with only five fairs is only a little in advance of Rutland, the smallest county in England, with three fairs.

But apart from these observations, there can be but little doubt that something in the nature of an economic boundary existed which divided Elizabethan England into two great commercial regions, characterized by significant differences in numbers of fairs and fair-sites and hence in volume and continuity of trade. One of these regions, composed of the counties of the eastern plain and fenland, and lying northeast of the road running from London to Manchester through Leicester (Figure 5), was served by only a few fairs held in widely separated communities. In the other, composed of the counties of the English heartland, the fairs were far greater in number and the fair sites in close proximity. South of this commercial borderland, which was itself marked with many fairs, there were 364 fair towns and 675 fairs; north of the economic frontier, however, there were only 95 fair towns and only 147 fairs. Indeed, three of the counties south of the boundary, namely Kent, Essex, and Wiltshire, with 20 per cent of the fairs, were better supplied with trading facilities than the eleven counties north of the boundary, with 17 per cent of the fairs. Of course, the fairs and fair sites of Yorkshire were almost as numerous as those of Essex (Figure 2), but the population and area of Yorkshire were also greater than the population and area of Essex. Hence, the northern county was less well supplied with fairs than the southern.

Temporal Distribution. It is suggested that this pronounced cleavage between the commercial habits and trading facilities of the northeast and

FIGURE 3.—County distribution of fair sites in the sixteenth century, showing some concentration in the channel counties of Kent and Essex; in Wiltshire; and in Lancashire, Cheshire, and Staffordshire.

southwest may be explained in part by border disorder in the extreme northwest and northeast. Judging by comments of Thomas Hodgkin in *The Wardens of the Marches* (1908) and D. L. L. Tough in *The Last Years of a Frontier* (1928), the English east, west, and middle marches, during the reign of Elizabeth, were still in a primitive or anarchic state, organized for cattle-thieving and defense rather than for settled existence and trade, a condition which might well have discouraged trade over adjacent territory to the south. At all events, in both Cumberland and Westmoreland there were only seven fairs during a brief summer trading season of four or five months. Durham similarly had but three fairs, and Northumberland seven, three of which were in Newcastle, and all of which were of only one day's duration.

Apart from this, however, climatic differences must also have played some part in determining the trading habits

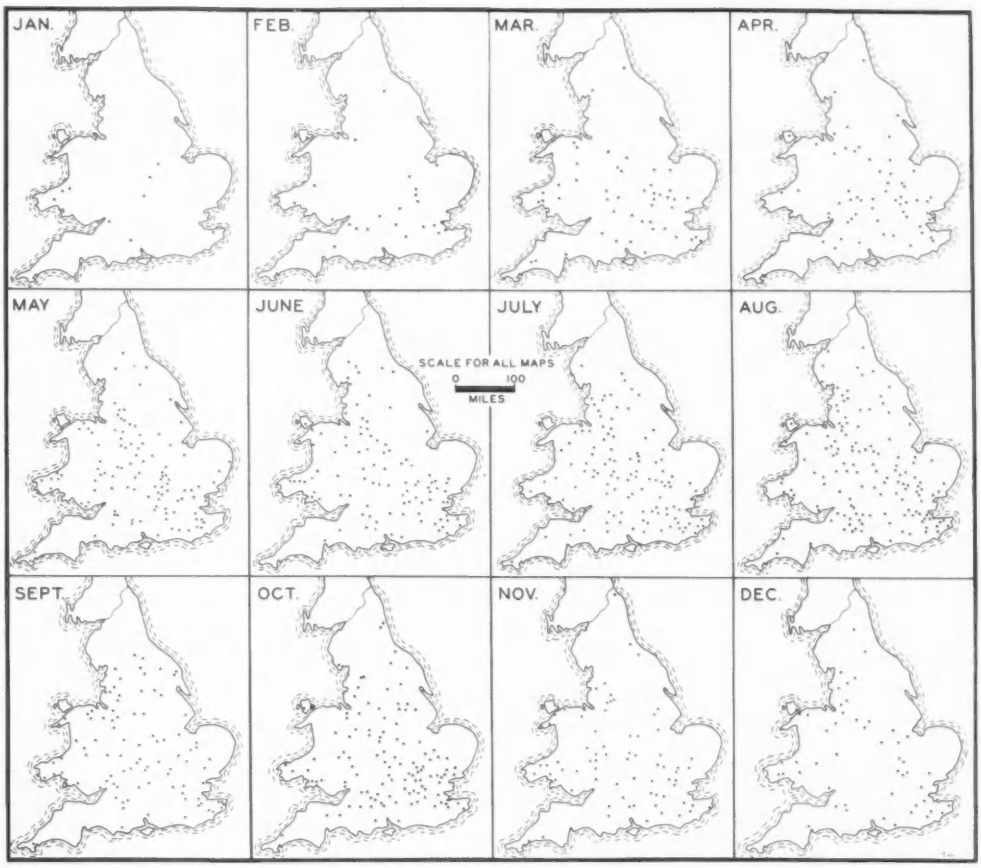


FIGURE 4.—Distribution of fair sites by month, suggesting the expansion of commercial activity from March through November, and its decline from December through January.

of north and south, although obviously this interpretation cannot be pushed too far. Customary fair dates (adjusted for discussion from the Gregorian to the New Style calendar of 1752) were undoubtedly set in the first instance to facilitate the distribution of agricultural products. Merchants making long journeys by land or sea were compelled to do most of their travelling between March and October. Road conditions were poor in winter and small ships dared not venture out during the period of storms. Much of the food, as well as other supplies, had to be sold or bought at certain seasons. After the harvest, the better arable areas had corn ready for buyers. After shearing, wool-producing districts had their clip to sell. After peasants had killed the cattle which could not be fed during the winter, they had many hides to be exchanged. Large buyers for household use regulated their purchases according to seasonal need and availability. The Earl of Northumberland, according to P. V. B. Jones in *The Household of a Tudor Nobleman* (1918), divided his purchases of beef into two lots, one being secured at Hallowe'en to be consumed on his estates until the following midsummer; the other, on St. Helen's Day in May for use during the summer. The Earl of Rutland bought his hogs for wintering late in October and his beef on May Day. Lenten food also

TABLE I

NUMBER OF FAIRS AND FAIR SITES BY MONTH, COUNTY AND REGION

Counties	*Number of Fair Sites*	*Jan.*	*Feb.*	*Mar.*	*Apr.*	*May*	*June*	*July*	*Aug.*	*Sept.*	*Oct.*	*Nov.*	*Dec.*	*Total Fairs*
Northeastern England														
Cumberland	5	..	..	..	..	..	2	1	3	..	1	..	..	7
Durham	3	..	..	1	..	..	1	..	1	..	..	..	..	3
Leicester	12	2	..	..	1	2	4	3	4	1	2	2	1	22
Lincoln	15	..	..	1	2	2	2	3	4	3	2	2	3	24
Norfolk	4	..	1	..	..	..	..	1	1	..	2	..	..	5
Northumberland	5	..	..	..	1	..	..	1	1	..	2	1	1	7
Nottingham	6	..	..	..	..	..	..	..	1	..	4	1	..	6
Rutland	2	..	..	..	1	..	1	..	..	1	..	..	..	3
Suffolk	11	..	..	1	1	3	2	2	1	3	3	2	..	18
Westmorland	4	..	..	1	1	1	4	..	..	..	..	..	..	7
York	28	..	1	..	1	3	3	9	11	8	6	1	2	45
	95	2	2	4	8	11	19	20	27	16	22	9	7	147
Southwestern England														
Bedford	11	..	1	4	2	4	3	2	4	2	4	2	1	29
Berkshire	9	..	2	1	1	1	2	2	2	1	3	..	1	16
Buckingham	14	..	1	2	..	8	3	3	1	..	2	1	..	21
Cambridge	7	..	..	2	2	1	2	2	4	1	2	..	..	16
Cheshire	14	..	1	..	1	4	4	4	6	4	3	2	2	31
Cornwall	10	..	..	2	3	2	..	1	2	1	2	2	..	15
Derby	7	..	..	1	1	5	2	..	2	2	2	..	2	17
Devon	4	..	..	1	..	1	1	2	1	..	1	..	2	9
Dorset	2	..	..	..	..	..	..	1	..	1	..	1	..	3
Essex	27	..	..	2	9	6	5	3	7	2	4	5	2	45
Gloucester	14	1	1	4	..	2	..	2	4	3	2	2	..	21
Hampshire	10	..	..	1	1	1	1	3	2	1	5	2	1	18
Hereford	6	..	..	1	1	5	..	1	1	1	2	3	..	15
Hertford	14	..	1	2	4	1	3	5	4	1	7	2	2	32
Huntingdon	7	..	1	..	2	1	..	1	2	1	1	1	2	12
Kent	42	1	4	3	5	7	7	8	15	9	10	4	6	79
Lancashire	24	..	..	..	2	5	3	7	7	5	4	7	5	45
Middlesex	8	..	..	..	1	1	..	3	1	2	3	..	..	11
Northampton	13	..	1	2	2	1	2	..	..	..	..	..	..	8
Oxford	7	1	..	1	2	1	1	2	2	3	3	1	..	17
Shropshire	16	..	..	..	..	5	6	5	7	2	4	5	2	36
Somerset	13	..	2	1	2	4	1	1	3	1	2	..	2	19
Stafford	18	..	..	3	2	6	2	5	5	2	5	1	..	31
Surrey	10	..	1	2	1	4	2	2	2	..	3	3	1	21
Sussex	12	..	..	1	1	4	4	4	3	1	..	3	2	23
Warwick	12	..	..	..	..	4	2	3	1	3	3	3	..	19
Wiltshire	22	1	1	1	3	6	7	6	8	4	6	2	2	47
Worcester	11	..	..	..	3	2	4	4	3	2	..	1	..	19
	364	4	17	37	51	92	67	82	99	55	83	53	35	675
Wales														
Anglesey	4	..	..	..	3	..	3	..	2	1	1	..	1	11
Brecknock	4	..	..	..	..	2	1	1	1	1	..	1	1	8
Cardigan	9	2	1	1	2	2	3	2	1	2	2	2	2	22
Carmarthen	13	1	1	4	..	1	2	1	3	3	2	4	2	24
Carnarvon	6	..	..	..	..	1	2	..	2	3	2	3	1	14
Denbigh	7	..	..	3	1	4	2	1	1	2	1	1	1	17
Flint	3	..	..	..	..	..	..	1	1	1	..	..	..	3
Glamorgan	10	..	1	..	..	3	1	4	3	2	2	1	1	18
Merioneth	3	..	..	..	..	..	1	2	1	..	..	..	1	5
Monmouth	6	..	..	..	2	..	4	..	2	2	2	1	1	14
Montgomery	6	..	..	1	..	1	1	2	1	3	2	2	1	14
Pembroke	11	..	..	..	..	3	2	2	2	1	2	2	1	15
Radnor	4	..	..	1	..	1	1	1	2	1	2	..	..	9
	86	3	3	10	8	18	23	17	22	22	18	17	13	174

had to be obtained at specified and convenient times, in order to be seasonably at hand for use. There was no economy in storing it longer than necessary, so that Michaelmas in September, or Candlemas in February, were usually considered timely dates for its purchase.

During the winter months there was

little commercial activity and that little was in southern England (Figure 4). In January there were only nine fairs in all Britain, of which the northernmost was in the Leicestershire village of Melton Mowbray. During the first month of the calendar year almost no one traded or travelled. In February, the fairs had more than doubled to 22, but 17 of these again were in southern England, suggesting a movement of goods between the Kentish coast and the Bristol Channel. Traders in the north, who desired to buy or sell in February in their own northern region were compelled to go either to Kings Lynn in Norfolk, or to Northallerton in Yorkshire. With the coming of spring, life on the roads became more active and in March the number of fairs again doubled to 51, the northerners being given two trading choices, one a 13-day fair in Durham and another of 10 days in Kendal. But while the fairs of the south, due possibly to the earlier movement of crops, reached their numerical peak in May, maximum commercial activity north of the economic frontier was postponed until August, a difference of four months. In the north where the harvest was late, the fairs were also late. Writing of Cumberland and Westmorland, Celia Fiennes observed that "they have only the summer graine, as barley oates, peas and lentiles, noe wheat or rhye, for they are so cold and late in their years they cannot venture at that sort of tillage." The trading season in southern England, and even in Wales, was ten months in length, or from March through December. But the trading season north of the economic frontier, except within certain local areas, was at best only half as long, or from June through October. Only one county in Wales (Cardigan) and two in England (Kent and Wiltshire) maintained facilities for trade at fairs throughout the whole 12-month period. While the whole of northeastern England, including Cambridgeshire, Norfolk, and Suffolk, was closed to those who sought to buy and sell at fairs for the winter quarter or third of the year. The months during which internal trade reached its height were May (in 41 counties), August (in 48 counties), and October (in 42 counties). Indeed, in August, the only counties which had no fairs were Rutland and Northampton, Dorset and Westmorland. While in Wales, every county had at least one August fair and some as many as three. The time of the year preferred for holding fairs was either during the autumn months when people were providing against the stoppage of all traffic on the roads during the winter months; or in the spring when they were compelled to replenish depleted stocks.

Duration and Recurrence of Fairs. In attempting to estimate the continuity and volume of trade carried on at fairs in the several commercial regions of Elizabethan England, it is necessary to consider first, the duration of fairs, or the length of time allotted by custom for the exchange of goods; and second, the recurrence of fairs, or the number held at specific sites during the course of the year. It seems plain that less business was transacted and the periodicity of trade was more marked in regions served by single and short fairs than in those where long and recurrent fairs were common. It may also be assumed that where the fairs were few or short there may have been a smaller surplus of production over local need and therefore less purchasing power than where fairs were long and recurrent. On the other hand, in communities, or areas, where long and recurrent fairs were the rule there was less marked periodicity of

trade and something approximating continuity of commercial activity.

With this in mind, and with Figure 5 as evidence, it seems plain that infrequent and rhythmical trading characterized 16th century England as a whole; that the typical fair was one day in length; and that the typical fair-site was the scene of a one-day fair once a year. Of the 545 fair sites listed in the almanacs, 51 per cent were the scenes of one-day fairs only (or fairs which were noted as occurring on the eve and morrow of a given date or Saints Day); 26 per cent were the sites of two-day fairs; and 22 per cent of fairs of three days or more duration. Indeed, with the exception of a few towns in Wales and Wiltshire, all of interior and western Britain was organized commercially on this basis of infrequent trading. In this large area, trade in fair towns was essentially periodic and discontinuous, although it may be urged that the short distance between fair sites and short intervals between fair dates lent some semblance of continuity to the trade of several smaller regions. In northern England again the same condition prevailed. Here although the proportion of long fairs was large, they were geographically and temporally so separated that neither the specific sites nor the region as a whole present themselves as scenes of continuous trade.

Nevertheless, there were relatively large sections of England, and certainly many towns, where the surplus of production over need, greater purchasing power or other causes, led to something approximating permanent commercial activity. In this connection it may be noted that 304 fairs, or 37 per cent of all fairs held in England, were from ten to fifteen days in length. But no significant county correlation appears between the number of fairs or fair sites and the number of long or recurrent fairs. Or to put the matter in another way, long or recurrent fairs were not more frequent in counties having a large number of fairs or fair sites, nor less frequent in counties having a small number of fairs or fair sites. The distribution of long and also recurrent fairs is far more closely associated with eastern and western ports of entry into England by sea, and with the commercial "boundary" between northeast and southwest. Relatively continuous trading, in this sense, occurred in Kent and Essex, where the crossing from the continent was shortest. Kent had 42 fairs of ten days or more duration and ten sites at which fairs took place three or more times a year. Essex had eighteen fairs of ten days or more duration and six sites at which fairs took place three or more times a year. Continuous trading also occurred on the Cheshire plain, with its frontage on the Irish Sea. Cheshire had 23 fairs

FIGURE 5.—Distribution of single and recurrent fairs in relation to seventeenth century roads (based on Ogilby), showing the continuity and concentration of trading activity in certain towns and regions. A. London. B. Leicester. C. Manchester.

of ten days or more duration and six sites at which fairs took place three or more times a year. Shropshire had six fairs of ten days or more duration and five sites at which fairs took place three or more times a year. Lancashire had 29 fairs of ten days or more duration and five sites at which fairs took place three or more times a year. And in conformity with the assertion that "in every epoch, fairs on the frontier flourished best," it occurred among those people who lived within trading range of the economic boundary between northeastern and southwestern England. Here on the "boundary" traders evidently found a more or less continuous market throughout the year. And here foreign merchants could hope to find a relatively constant demand for continental goods and luxuries.

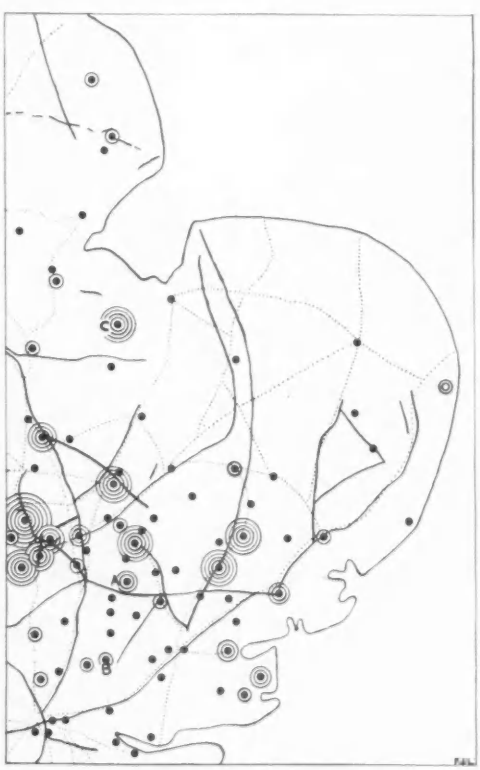


FIGURE 6.—Fair sites of East Anglia in relation to Roman and seventeenth century roads; suggesting that Roman roads were in use in the sixteenth century to accommodate traffic to A. Thremhall, B. Epping, C. Wisbech. The solid line indicates Roman roads and the dotted line seventeenth century roads.

Fairs and Highways. It is commonly said that the roads of sixteenth century England were deplorable and caused internal trade to be inter-municipal rather than nationwide. Since each shire had many weekly markets, and since few communities were more than three or four miles from the nearest of these, commentators are convinced that there was no economic need for good roads, apart from those communicating with seaports, fortresses, and the greater fairs. It is also asserted that long distance commercial traffic was comparatively slight. These opinions are partially upheld by the great series of highway acts initiated by Elizabeth and by the complaints of travelers, both English and foreign.

Nevertheless evidence of another type suggests that the roads were probably not as impassable as they were pictured, nor was the long distance land-carriage of goods as limited as sometimes implied. From time immemorial the roads, poor as they were, had sufficed to carry a heavy movement of pedestrians, horsemen, pack horses, carts, and horse-drawn wagons. They were used by farmers visiting the local markets, by itinerant traders who carried overseas goods to the fairs, by merchants collecting raw materials and distributing finished products, and by herdsmen driving cattle and sheep over distances to be measured in hundreds of miles. The very existence of a class of common carriers who made their living by regularly traversing the country from Southampton and Winchester to Oxford, from the midland counties to Stourbridge fair near Cambridge, and even from Oxford to Newcastle-on-Tyne, is proof that there was a demand for carriage

and that the roads or trackways were kept in relatively adequate repair.

Although long journeys in the reign of Elizabeth were accomplished on horseback, the newly introduced coach was in occasional use over a distance of sixty miles between London and Oxford, and in other parts of the realm. Furthermore, large landowners, supervising widely separated estates were compelled to travel continuously from one to another. Their purchasing agents, who were charged with the duty of buying provisions for many households, were constantly on the roads making the rounds of the fairs. In so doing, they often patronized neighborhood marts, but some evidence is at hand to indicate that they ranged far from home estates to commercial centers at some distance. During the sixteenth century, the Earl of Rutland, for example, bought Lenten provisions at Lynn; wine, vinegar, salt and iron at Boston; Rhenish wines, torches, and drinking glasses in London; and rope in Nottingham. Similarly, the Willoughbys of Wallaton, in Nottinghamshire, secured some of their supplies nearby at Litchfield, Stourbridge, Lenton, Newark, Birmingham, Chesterfield, and Fazesly; but purchased cattle at the far-away fairs of Gravesend, Braksted, and Cowden in Kent; at Wythyham fair in Sussex, and even from "Adylton fair in Yorkshire." Road conditions may have been such as to interfere with easy access to centers of trade, but they did not prevent it. The very existence of almost a thousand fairs, together with over three hundred important fair towns, testifies to the widespread and long distance use of what roads there were.

With these facts in mind, it is of some interest to determine whether the road maps portraying 16th century routes of land travel rationalize the position of the fairs and indicate all of the tracks

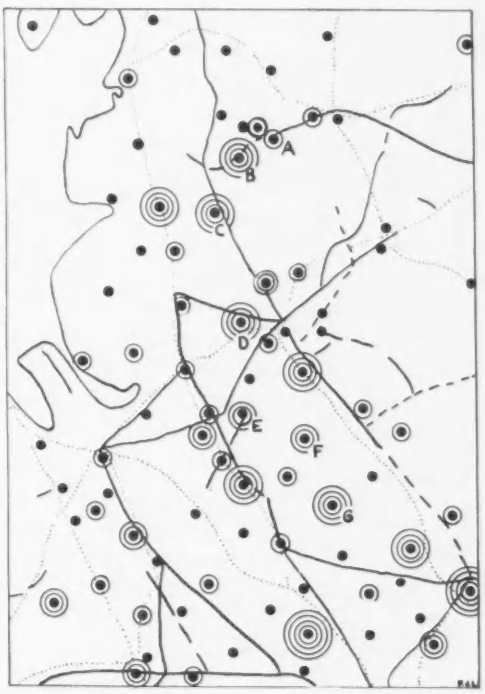


FIGURE 7.—Fairs of a part of Lancashire and Cheshire and their relation to the road system. A. Gisburne, B. Clitheroe, C. Blackburn, D. Bury, E. Knutsford, F. Macclesfield, G. Leek. The solid line indicates Roman roads, and the dotted line seventeenth century roads.

and roads in actual use by Elizabethan buyers and sellers. Only two maps are available for this purpose; one exhibiting 16th century communications compiled from Jean Bernard's *Guide de Chemins* of 1571 and other materials (Taylor, E. G. R. "Camden's England" in Darby, H. D. *An historical geography of England before A.D. 1800* [1936] 342); the other, John Ogilby's *Brittannia or the Kingdom of England and Dominion of Wales of 1675*, in which the first comprehensive survey of British roads was made. The road systems projected in both of these maps is a radial one with London as a center, Ogilby alone indicating the intersection of radial lines of communication by many crossroads. (Figure 5.)

When the distribution of fairs is compared with the map based upon

the French *Guide de Chemins*, hundreds of them are left without road connection. Obviously this map fails to present a complete projection of the road system in actual use. When, on the other hand, the Ogilby map ("Map of XVII Century England." Ordnance Survey. 1930) is compared with the fair distribution (Figure 5), the position of the great commercial towns, or the centers of more or less continuous trading at long or recurrent fairs, is to a large degree explained. These nodal sites, as might be anticipated, are shown as located at well defined road intersections or near to some recognized line of travel. And many of the great fair towns of England not only bound the relatively fairless region of the eastern plain, but lie in immediate proximity to the road from London through Leicester to Manchester; which seems in turn, to form the "boundary" line between the northeastern region and that of the southwest.

But even Ogilby's map fails to account for a significant number of important fairs and fair clusters. Wisbech, Epping, and Thremhall in Cambridgeshire and Essex; Partney, Louth, Gainsborough, and Crowle in Lincolnshire; Selby and Stokesley in Yorkshire; all of these appear without road connection, as is also the case for a cluster of fairs in Lancashire (Gisburne, Clitheroe, Blackburne and Bury); and on the Cheshire plain (Knutsford, Macclesfield, Leek, Drayton, Wellington, and Shifnal). Wisbech, Selby, and Gainsborough, of course, were on navigable rivers which permitted the import and export of goods overseas. The absence of road connection, however, fails to explain how overseas goods were carried to inland buyers, or inland products brought to the ports. It is only when the fair distribution is compared with a map of Roman communications that these roadless centers of trade are brought, in some cases, into relation with possible lines of transport. In East Anglia, for example, Thremhall and Epping, which lie far from any road recorded by Ogilby, are plainly accessible on Roman roads, while Wisbech lies between two Roman roads (Figure 6). In Lancashire the important 16th century fair centers of Gisburne, Clitheroe, and Blackburn are inaccessible unless the use of Roman roads be assumed (Figure 7). Doubtless many more, if not all, fair sites could be rationalized if the map of Roman roads could be supplemented with a map of trackways. It thus seems reasonably certain that the Roman roads which rationalize the position of important or even minor fair sites were still in use during the Elizabethan period, together with many trackways. It suggests that when the time comes to reconstruct a map of 16th century communications, or for that matter, earlier centuries, the distribution of fairs should not be ignored.

INDIAN LAND IN THE CHEROKEE COUNTRY OF OKLAHOMA

Leslie Hewes

ONE of the most important of social and economic facts in the former Indian Territory in what is now eastern Oklahoma is the existence of a large amount of Indian-owned land, much of which is restricted against sale and is tax-exempt. In the Cherokee Country there is much Indian land. It has seemed pertinent to inquire into the extent, quality, and use of such land, with the purpose of evaluating the broad significance of Indian land. Emphasis will be given land in the eastern, wooded, or Ozarkian portion of the former Cherokee Nation (Figure 1), which served as culture hearth for the Cherokees in Oklahoma, and is still the home of the majority.

Extent of Land of the "Real" Indians

The allotment of land in the Cherokee Nation was made between 1903 and 1910 by the Commission to the Five Civilized Tribes, commonly called the Dawes Commission after its first chairman, Henry L. Dawes, despite the treaty guaranteeing the land to the Cherokee Nation forever. Indians of half-blood and over were allotted about half the land of the Cherokee Country east of the Grand and Arkansas rivers, roughly the Oklahoma Ozarks.

In an area of some 1,980,000 acres the allotments of Indians of half-blood or more (now, generally speaking, called "restricted" Indians) totaled about 980,000 acres, of which about 720,000 acres were allotted to full-bloods. Cherokee citizens of less than one-half Indian blood, including intermarried whites, received about 810,000 acres; freedmen, 148,000 acres. (These acreages were derived from detailed maps of allotments by degree of blood which were made by checking the rolls for the degree of blood of all allottees in the Cherokee Nation.) Some 40,000 acres were not allotted (J. Geo. Wright, "Rept. of the Commissioner to the Five Civilized Tribes," *Annual Repts. Dept. Interior*, 1910, Vol. II, p. 169). For the entire Cherokee Nation, whose area was 4,420,067.73 acres, the land was allotted as follows: restricted Indians, approximately 1,544,000 acres, of which about 1,036,000 acres were allotted to full-bloods; white Indians and intermarried whites, about 2,315,000 acres; freedmen, approximately 465,000 acres; and not allotted, or subject to contest (about 1910), nearly 96,000 acres.

Most of the land allotted to citizens of the Cherokee Nation has in the short period of three decades passed into the hands of the majority white population. The transfer was delayed most in the case of the restricted Indians, whose lands were subject to restrictions against sale. However, there has been a marked shrinkage of restricted land. The rate of loss has been least in the eastern, or Ozarkian, section. Even here, the restricted Indians retain only a little over one-third the acreage allotted to them about a third of a century ago. The restricted Indian land of the four counties entirely or mainly in the Ozark section was reported as amounting to 322,545.5 acres as of November 23, 1938 (Files, Land Acquisition, Five Civilized Tribes, Muskogee). With the addition

FIGURE 1.—The Cherokee Nation, shown by heavy outline, with physical divisions and present counties.

of restricted land located in those parts of Mayes, Muskogee, and Wagoner counties which lie east of the Grand and Arkansas, the regional total would be somewhat in excess of 350,000 acres, or over one-sixth of the land area. The following table gives the acreage in 1938 by counties for the entire Cherokee Nation.

The rate of loss of restricted Indian land has been reduced in recent years. Restricted land in the Ozarkian section in 1929 amounted to approximately 420,000 acres, according to "Tax-exempt Indian Lands," *Senate Rept.* No. 1365, 72nd Cong., 2nd Sess. (1933), pp. 98f. Most of the restricted land which is now taxable was tax-exempt in 1929, since holdings in excess of 160 acres were not made taxable until 1932. Accordingly, the loss in the nine years following 1929 was approximately 70,000 acres as compared with nearly 560,000 acres alienated between the time of allotment (1903–1910) and 1929.

In spite of the tremendous shrinkage of Indian lands, the restricted Indians as a class are not poor in land, except in its quality. In the Oklahoma Ozarks the restricted Indians form only about one-twelfth of the total population but own more than one-sixth of all the land.

TABLE I

AMOUNT OF RESTRICTED INDIAN LAND IN THE CHEROKEE NATION

Counties	*Restricted Tax-exempt acres*	*Restricted (a) Taxable acres*	*Total (b) Restricted acres*
Adair	67,943.00	21,212.00	89,155.00 (c)
Cherokee	77,920.00	22,630.00	100,550.00 (c)
Craig	13,590.00	1,990.00	15,580.00
Delaware	56,809.00	19,920.50	76,729.50 (d)
Mayes	35,351.00	3,900.00	39,251.00 (d)
McIntosh	4,377.33	752.50	5,129.83
Muskogee	14,790.97	1,459.00	16,249.97 (d)
Nowata	19,460.00	2,790.00	22,250.00
Ottawa	3,750.00	.....	3,750.00
Rogers	14,986.52	.....	14,986.52
Sequoyah	44,241.00	11,870.00	56,111.00 (c)
Tulsa	9,977.30	1,080.00	11,057.30
Wagoner	3,116.64	787.92	3,904.56 (d)
Washington	32,067.00	2,660.00	34,727.00
Totals	398,379.76	91,951.92	489,431.68

(a) Consists mainly of holdings in excess of 160 acres.
(b) These totals do not include the very limited acreage owned by Indians of half-blood or more who have been declared legally competent, and whose land, accordingly, are not restricted.
(c) Entirely within eastern, Ozarkian section.
(d) Partially in eastern, Ozarkian section.

FIGURE 2.—Sycamore Spring, Delaware County. A community of restricted Indians is located about this spring. Springs are still esteemed water sources in the Cherokee Ozarks.

LAND TENURE AMONG THE INDIANS

Most of the restricted Indian families have land. A sampling of a recent survey (*Economic and Social Survey of 1933–4*) showed only 90 of 318 individuals (family heads plus any others in the family who had ever owned any land) to be without land. (This survey was conducted under the direction of the Five Civilized Tribes Agency and was intended to obtain information about all the Indians of all degrees of blood. The survey was halted before much work was done in the central and southern parts of the Cherokee Ozarks. In 1936 the records cards were on file in the basement of the Federal Building, Muskogee. The results had not been tabulated, although many of the records had been checked and corrections of degree of blood made.) Most of the individuals included in the sampling lived in Delaware and Mayes counties. For the Cherokee Nation comparable figures were 125 of 412, or 30.3 per cent. The percentage of restricted Indian families of the Ozarks owning land is probably somewhat more than the 71.1 per cent obtained in the sampling since in some instances those without land were members of families in which other members owned land. Thirty-seven of the 70 who had been declared competent by law were landless, which is certainly a striking demonstration of the need of the real Indians for the protection of "restriction."

Table II, which is based on data from the United States Census of 1930, shows that the Indians are more commonly owners of the farms they operate than either the whites or Negroes.

TABLE II

PERCENTAGE OF OWNERS AMONG FARM OPERATORS

	Colored		*White*	
	1925	*1930*	*1925*	*1930*
Adair Co.	76.9	64.6	56.0	49.8
Delaware Co.	74.7	72.6	56.0	55.5
Cherokee Co.	59.2	56.0	41.4	38.7
Sequoyah Co.	44.1	41.9	30.8	26.9

Since Adair and Delaware counties have no Negro inhabitants, the above census for "colored" farmers are for Indians only. In Cherokee and Sequoyah counties the lower percentage of owners among the "colored" farmers is due largely to the inclusion of a considerable number of Negroes. The percentage of farm owner-operation for restricted Indians may well have been higher than that given for the Indian

FIGURE 3.—View of the type of country esteemed by Cherokee pioneers and still the residence of many restricted Cherokees. Small stream in southern part of Springfield structural plain.

("colored") population of Adair and Delaware counties because many Indians of less than half-blood were included in the census data. In four small areas, totaling about 17 square miles, mapped in the field in 1935 and 1936, the 43 resident restricted (half-blood or more) Indian families were classified as follows: full owners 27, part owners 3, tenants 13. Approximately 70 per cent were owners of the land on which they lived. The preference of some Indians to rent or "squat" on land belonging to relatives or friends rather than occupy distant or poor lands of their own is a reason for somewhat more tenancy among the restricted Indians than land-ownership data would suggest.

There is a possibility that the federal government may acquire by purchase privately owned land, including taxable restricted land, in sufficient amount to provide land for the use of many of the landless restricted Indians. Controlled grazing, farming, and wood-cutting would be carried on by the Indians on the purchased land. Title to the land would remain with the government. To a considerable extent the plans call for a return to pre-allotment conditions. The purchasing of land has begun.

QUALITY OF INDIAN LAND

Most of the land of the Oklahoma Ozarks is inferior to that of the western prairies of the Cherokee Nation. The average value placed by the Dawes Commission appraisers, as computed from appraisal records in the Division of Indian Lands and Money, Five Civilized Tribes, on the land in the townships mainly or entirely to the east of the Grand and Arkansas rivers was $2.07 an acre; those to the west, $3.70 an acre. Most of the better lands of the Cherokee Country were occupied by white Indians and freedmen and were allotted to those groups. The restricted Indians received mainly poor land (Figure 2). The general distribution of the allotments of the restricted Indians as related to appraised value of land is shown in Figure 5.

The Indian farms are on the average less valuable than those belonging to the whites and Negroes. The average value of land in farms (plus buildings) per acre according to the color of the farm operator as computed from the census reports for the two counties in which Indian and "colored" farm operators are synonymous is shown in the following table.

TABLE III

AVERAGE VALUE OF FARM LAND AND BUILDINGS PER ACRE

	1920		190		1935	
	Indian	*White*	*Indian*	*White*	*Indian*	*White*
Adair Co.	$26.91	$33.25	$26.71	$31.86	$13.28	$16.02
Delaware Co.	33.31	38.92	23.82	29.86	15.74	17.77

According to the 1940 census, the average per acre valuations of Indian-owned and white-owned lands (without buildings), respectively, were Adair, $12.41 and $12.23; Delaware, $11.87 and $19.37. The actual difference in value between white-owned land and the land of restricted Indians, who are not the only Indians classed as "colored" or "non-white" in the census, may be greater than the census data indicate. Essential equality of value of "colored," or "non-white," and white-owned farm land in Sequoyah County and the location of the chief Negro settlements in the Arkansas Valley can be taken as demonstrating the greater value of Negro-owned than Indian-owned land.

The poor quality of the land and the scattered distribution of family lands are much more significant factors in the general poverty of the restricted Indians and the poverty of cultural landscapes in the Indian districts of the Cherokee Ozarks than any general shortage of Indian land. However, under present trends shortage of land due to sale will soon make the land problem critical.

USE OF INDIAN LANDS

Some land west of the Grand and Arkansas is owned by restricted Indians who live to the east. In a good many cases allotments were completed by the addition of western prairie lands. Approximately one-fifth of the restricted Cherokee Indians included in a survey made in 1927 (*Census of Cherokee Indians Owning Restricted Individual Allotted Land, June 30, 1927*, Five Civilized

FIGURE 4.—Farming district south of Stilwell, county seat of Adair County. The "basin-valley" in foreground is occupied by whites and Indians of less than half-blood. Many restricted Indians live among the hills beyond (to the south), at the northern edge of the Boston Mountains.

Tribes) owned land both to the east and the west of the rivers.

The western lands have been of little benefit to the restricted Indians of the Cherokee Ozarks, except through sale. Land at a distance and poorly known could not be managed successfully. The small return from such land was the subject of official reports on a number of occasions. A report made in 1928 reads as follows, "That part of the district west of Grand River is mostly prairie land, and a large part of Craig, Mayes, and Nowata counties is restricted land and belongs to Indians who in most part live east of Grand River in this [northern] district and the Tahlequah district. . . . The prairie land in Craig, Nowata, Washington, and Rogers counties allotted to the restricted Indians and from which the restrictions have not been removed, for the most part is being used by parties who obtain 5-year leases on the surplus land direct from the Indians on commercial form leases for a very small consideration, and in a great many cases use the homestead allotment without paying for the same" (Fred A. Rogers, field clerk, to C. L. Ellis, reproduced in *Survey of Conditions of the Indians in the United States, Hearings before a sub-committee of the Committee on Indian Affairs, U. S. Senate* [1931], pt. 14, pp. 6630f.). Comparatively few Indians living east of the Grand and Arkansas rivers received lease or royalty money resulting from the early oil production in the prairie section. The chief material asset of the restricted Indians of the Cherokee Ozarks is the land that they retain east of the Grand and Arkansas rivers.

The poor quality of Indian lands is as much a potential limitation as an actual limitation on their use. A common opinion of men in the Indian Service, and of whites, unrestricted Indians, and the more progressive restricted Indians of the area is that the chief limitation on the use of Indian land is to be found in the Indians rather than in the land.

The limited use made of Indian land is apparent to one traveling through a restricted Indian community. Investigation reveals that most of the livestock ranging through the woods and in some areas many of the crops grown on restricted Indian land are the property of white men or unrestricted Indians. In order to obtain reliable information on the use made of Indian lands, the data collected in several surveys were studied and maps of land utilization were made in the field.

The uncompiled records of the *Economic and Social Survey of 1933–4* constitute probably the largest body of available data. Tabulation of sampling gave the results shown in the following table. (For economy of time the cards were selected from those parts of the files in which the records were largely for restricted Indians; that is, most of the individuals included lived in Indian settlements. If the data had represented mainly restricted Indians living chiefly in white communities, the figures for cultivated acreage might be somewhat higher than those obtained in this sampling.)

The percentage of the Indian land cultivated (17.0) is somewhat less than the regional average. In Delaware County, in which much of the land included in the survey is located, according to census figures, 23 per cent was classed as crop land in 1934, and 24.6 per cent in 1929. The somewhat lower figure for the Indian lands may be due to their lower average quality or to the scattered distribution of the holdings of a single individual. The average acreage (24.9) cultivated by the restricted Indian farmers who were reported as cultivating their land was

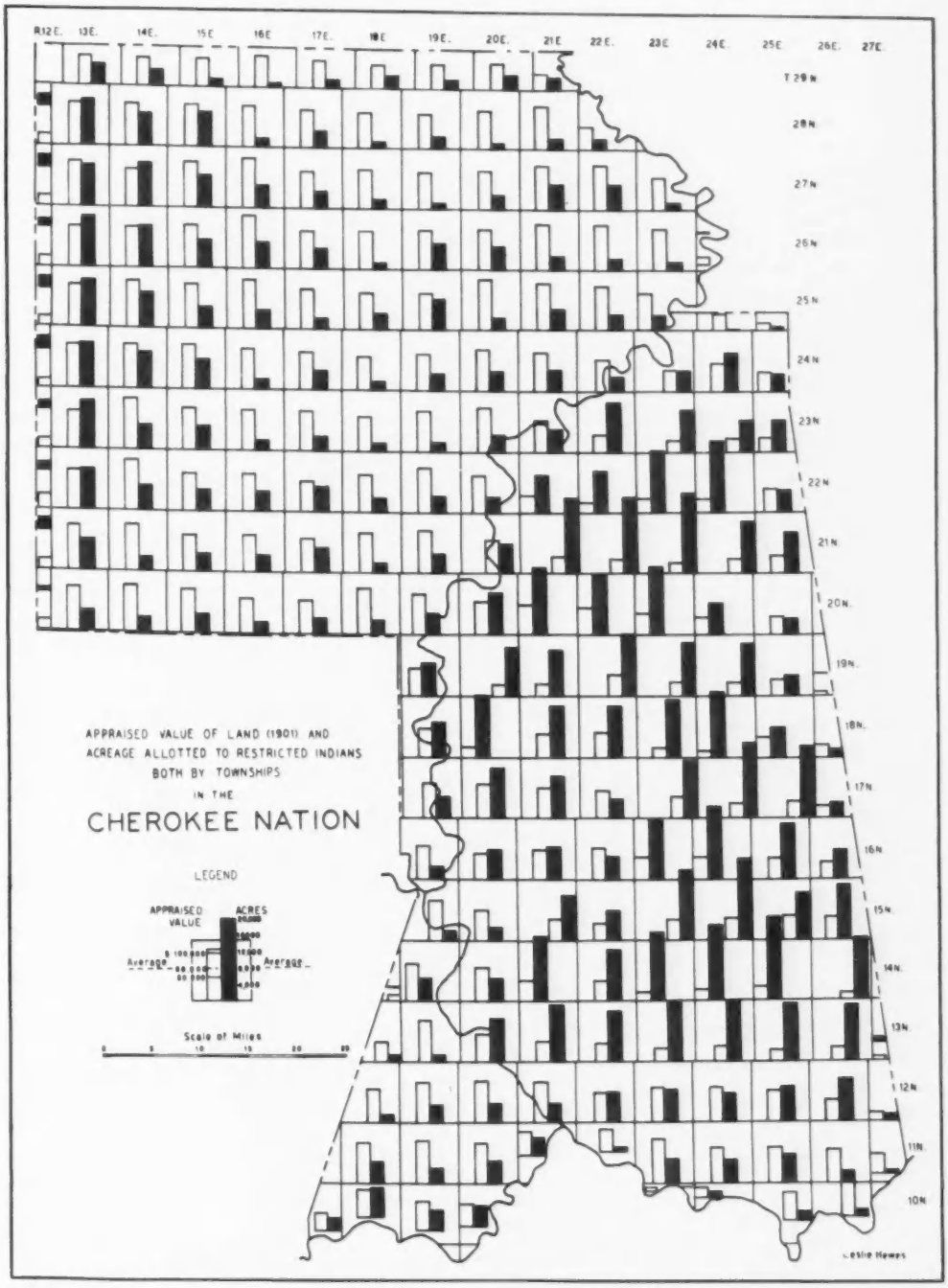


FIGURE 5.—Little land was selected by the Indians of half-blood or more in the Arkansas Valley, Cowskin Prairie (northern Delaware County), or other better than average districts in the eastern part of the Cherokee Nation, and but little in the western prairies, except along the western edge where much speculative oil land was selected. (Appraised value from files, Five Civilized Tribes agency; distribution of allotments of restricted Indians determined from old allotment maps and official rolls.)

TABLE IV

OWNERSHIP AND USE OF INDIAN LAND

Number of individuals (Indians of half-blood or more resident in the Oklahoma Ozarks who were heads of families; also those not family heads who were reported as ever owning land)	311
Number owning land at time of survey	221
Number of acres owned	19,795 acres
Number of landowners who cultivated some of their land	82
Percentage of landowners cultivating some of own land	37.1%
Number of acres cultivated by these 82	2,038 acres
Number of acres cultivated per Indian cultivator	24.9 acres
Number of acres cultivated per landowner	9.2 acres
Number landowners who leased land to others for cultivation	45
Percentage of land owned cultivated by owner	10.3%
Cultivated land leased to others	1,322 acres
Percentage of cultivated land leased	39.4%
Number of landowners who leased land to others for cultivation and cultivated none themselves	36
Percentage of land cultivated by owner and lessee	17.0%
Total number landowners leasing some land (all purposes)	57
All land leased to others	4,768 acres
Percentage of land leased	24.1%

much less than the average for Delaware County (43.5 acres of crop land in 1934), but was comparable to that of the poorest townships of the county. However, most of the restricted Indian land owners (62.9%) were reported as not cultivating any of their land, lowering the average (9.2 acres) per Indian farmer far below that of the poorest townships in the region. Nearly 40 per cent of the cultivation on Indian lands, it was indicated, was carried on by renters, presumably mainly white.

The data given above show that the average Indian landowner was unable or unwilling to cultivate as much land as the average white owner or tenant, although nearly as much of the Indian owned land was in cultivation. Supporting data of statistical character are furnished by a study made in Cherokee County (Thomas Aldis Hall, *The Socio-Economic Status of the Cherokee Indians*, Master's thesis, University of Oklahoma, 1934, p. 74). Data collected for 99 "farms," including several operated by Indians of less than half-blood, which probably raised the average, showed the average area cultivated to be 16 acres. Twenty-four of the "farms" were reported as having no cultivated land. My maps of land utilization showed an average of 9.2 acres of crop land and 5.9 acres actually in crops per Indian household resident in the four communities mapped.

Each of the several sets of data indicates little cultivation by the restricted Indians. The land cultivated by the average rural family probably amounts to no more than ten acres. An average as high as ten acres is made possible by the fact that some Indians cultivate as much as the average white farmer of the region. My maps of land utilization show only 20 of 44 Indian families cultivating more than garden plots, and 13 of the 43 resident Indian families cultivating 10 acres or more each.

The restricted Indians, as a group, are very poorly supplied with draft animals or basic farming implements. It is estimated that no more than one-fourth of the restricted Indians of the northern district have teams. Hall found that in a total of 100 families only 16 owned horses, 26 owned mules, and 44 owned any farm implements. In some cases, in the recent years of poor crops and little employment, Indians have been forced to dispose of their teams. Other Indians, it is claimed, have never

owned draft animals nor shown any interest in farming.

There is a fairly general opinion among those long resident in the area that the restricted Indians as a class do less farming than before the allotment of land. The practice of renting land, including crop land, to white farmers is now more common among restricted Indians than formerly. The detailed field maps show whites responsible for an even larger part of the cultivation of restricted Indian land than shown by the sampling of the *Economic and Social Survey of 1933–4*. In two of the four areas in which land utilization was mapped, it was found that white renters used more Indian land than the Indians. This was most notable in the community located in a cotton growing section. Chiefly because of the large amount of land rented to whites in this district, the summary of the data for the four areas shows that nearly twice as much fenced Indian land was used by white renters as by Indians (1,396 to 736 acres), somewhat more crop land was available for use by whites (430 to 397 acres), and whites used nearly four times as much fenced pasture as the Indians (620 to 168 acres).

A number of official reports have called attention to the uneconomic leases often made by restricted Indians and the harmful results of the practice. One of the harmful results early recognized was the attraction of inferior white renters, who constructed very poor improvements and committed waste. Wastage of Indian land by white renters continues. Much Indian land which is rented or has been rented by whites has been ruined, especially in the sandstone and shale areas in the southern portion of the region. It appears that the whites as renters and owners use more poor upland and sloping land, as well as more of the best land, than the Indians, and are accordingly responsible for most of the soil waste.

In 1912 the Indian was described as land poor (Dana H. Kelsey in *Rept. Commissioner Five Civilized Tribes, Rept. Dept. Interior*, 1912, II, p. 483), and the benefits, such as the acquisition of livestock and tools, to be derived from the sale of some of the land, were urged. The opportunity to imitate white farmers who had come into Indian communities by the purchase of Indian lands was extolled as a beneficial result of the sale of land. In view of the present status of Indian agriculture, the beneficial effects of the sale of land can be questioned. Lack of capital and inability to obtain credit are still pointed out as basic obstacles to the productive use of Indian lands generally (Alan G. Harper in "Indian Land Tenure, Economic Status, and Population Trends," *Supplementary Rept., Land Planning Committee to Nat'l Resources Board*,

FIGURE 6.—Main field of full-blood Cherokee on second bottom of small stream in southern Adair County. Rail fences, deadenings made by girdling, corn, and stream-side location, as shown, are important considerations in Indian farming.

pt. X [1935], p. 3). The restricted Cherokee farmer, however, is not as "land poor" as in 1912 and has not paid land taxes, but appears no more able to use his land productively now than then. Self-support by subsistence agriculture is the modest goal held for the restricted Indians of the Five Civilized Tribes by the Indian Service.

On the whole, the restricted Indians make less use of the land today than they did prior to the date of allotment. No significant advance has been made in use for crops. The losses in game have been offset largely by increased dependence on the cutting of wood. The greatest loss has been in stock raising.

Although the "real" Indians of the area never had their per capita share of the stock, they are now poorer in that respect than in the past. The recent poor crop years have in some cases made necessary the sale of animals, but, according to local information, the impoverishment of the herds of the Indians has been going on since the per capita payment of 1895 (consisting of proceeds from the sale of land in north central and northwestern Oklahoma), which is said to have given a taste for easy living. In most Indian districts there are few animals owned by the restricted Indians to compete on the woodland range with the stock owned by whites and unrestricted Indians. Hall found 25 of 100 families keeping cattle; 58, hogs; and 71, poultry. The limited use of dairy products by the restricted Indian is well known, and, in part, must be considered due to distaste for the systematic care required by the animals. Other animal industries also suffer from neglect.

The arduous tasks of enclosing land and raising hay and feed crops in the interest of a more efficient animal industry have not appealed to the Indians. Fenced pastures and hay lands in the general area are few in number and rarely seen on the farms of restricted Indians. In the areas mapped in the field only 10 of 43 resident Indian households had either a fenced pasture or hay field. Eight had fenced pastures; 4 had hay fields.

The expectation that the Indians of the restricted group would profit by the ending of tribal government has not been fulfilled. It was hoped that the "real" Indians would obtain and use more land and that the responsibilities of ownership of land in severalty would develop business ability. It is true that much of the Indian land is poor and some holdings are scattered, but poverty and distaste for more than the most elementary farming are more important reasons for the failure of allotment to benefit the restricted Indians. Many of the restricted group opposed the allotment of land, and, it may be said, continue to dislike the rules of the game they are expected to play. Mention of the deer hunt, or of bee trees, or the "buckeyeing" of fish brings a much more pleased expression to the face of the full-blood than reference to a dairy cow, grain binder, or orchard. There is little doubt that to the restricted Indians the old days were best.

BROAD SIGNIFICANCE OF INDIAN LAND

The ease with which Indian land is rented and the difficulty with which it can be bought are significant causes of the large amount of tenancy in the Oklahoma Ozarks. The percentage of the farmers who are tenants is higher in each county than in the nearest county in the Arkansas and Missouri Ozarks or in the Ozarkian sections of those states generally. The tradition of the white man as a tenant is probably equally important. Cotton economy, which was

practiced even before the allotment of land, has strengthened the tenancy system in part of the region.

The exemption of the lands of the restricted Indians from taxation, although an absolute necessity for the existence of such land, has helped to retard the area. A reduced tax base has resulted in reduced community services in areas in which such services are needed most. Roads, for example, have suffered in such areas. The losses on schools have been more or less completely offset by federal aid in the form of tuition for Indian children, although the payments have been inequitable because prior to the school year, 1938–1939, they were made for the school attendance of Indian children of all degrees of blood, whereas only the lands of restricted Indians are tax-exempt. Now tuition is paid for the attendance of children of one-fourth blood or more. In recent years considerable expenditures have been made by the federal government for outright "relief" of indigent Indians and for road-building in Indian districts by Indians. The following table shows the federal tuition paid in 1931, a year of maximum payment, the reported tax loss of 1929, and also expenditures by county governments on tax-exempt land or in behalf of restricted Indians in 1929 where reported. It is apparent that the existence of restricted Indian land has been a financial liability to the region. Probably every county is poorer because of the existence of restricted Indian land.

FIGURE 7.—Tom Cornshucker's farm on small stream in eastern Delaware County.

The existence of much Indian land has been an important factor in evolving the present regional culture. Neither Indians nor whites have used the Indian lands efficiently, and both the Indians and their lands have been exploited by the whites. The lack of capital and limited outlook of many white renters and Indian owners have delayed improvement. The tax loss because of Indian lands has had a retarding effect. Many traits of the culture complex of the region have been developed largely

TABLE V

PROFIT AND LOSS ON RESTRICTED INDIANS BY COUNTIES (a)

	Tax Loss	*Expenditure for restricted Indians or on Indian land*	*Total Loss reported*	*Tuition payments to counties*
Adair Co.	$17,568.16	unreported	$17,568.05	$25,007.13
Cherokee Co.	47,808.00	unreported	47,808.00	16,637.30
Delaware Co.	38,059.00	$5,000.00 (c)	43,059.00	18,539.81
Mayes Co. (b)	24,216.77	18,455.56 (d)	42,672.33	13,615.16
Sequoyah Co.	14,371.50	unreported	14,371.50	15,777.76

(a) Source: *Tax Exempt Indian Lands, Senate Report* No. 1365, 72nd Congress, 2nd session (1933), pp. 98f.
(b) Included because most of the tax-exempt land is situated in the Cherokee Ozarks.
(c) Unreported except for law enforcement.
(d) Law enforcement and road building reported.

about the Indian lands. The prominence of renting, the exploitation of resources, the low standards of land use, the low standards of housing, and the meagreness of community service are all to a considerable degree based on the past and present existence of much Indian-owned land. The result has not been a balanced economy nor a pleasing cultural landscape.

MICHIGAN LIMESTONE IN THE GREAT LAKES STONE TRADE

Paul Cross Morrison

STONE has been a major commodity of commerce on the Great Lakes for almost three decades, yet public knowledge concerning this trade is limited. This is because the business of producing and transporting stone is highly competitive, and because vertical integration of consumer, shipping company, and quarry limits the possible sources of information. Facts compiled by the writer lack desired completeness, but are believed sufficient for a reasonably accurate appraisal of the character of the Great Lakes stone trade and the part of Michigan quarries in this trade. Such is the purpose of this paper. Statistics for 1937 are largely used, being the latest available at the time the study was initiated.

There is no record of annual lake shipments of stone before 1915, but in that year 3,854,106 net tons were moved. Stone transported in 1918 exceeded grain shipments for the first time. Since then stone has been the third most important item of bulk freight carried during some years and grain during other years. Iron ore and bituminous coal are usually first and second in importance (Figure 1). Record breaking lake shipments of stone during 1941 totalled 17,633,448 net tons, considerably exceeding the previous high of 16,269,612 net tons in 1929.

Importance of Michigan Quarries

Practically all stone moved on the Great Lakes is crushed and broken limestone, largely from Michigan. During 1937, for example, almost 90 per cent of the 14,429,379 net tons carried came from five Michigan quarries. Any study of the Great Lakes stone trade thus becomes primarily a study of the trade in Michigan produced limestone.

Michigan quarries shipping stone by water are the Michigan Limestone and Chemical Company, Calcite; the Inland Lime & Stone Company, Port Inland; the Michigan Alkali Company and the Thunder Bay Quarries Company, Alpena; and the Kelley Island Lime & Transport Company, Rockport (Figure 2). Principal ports of origin outside of Michigan are Sturgeon Bay, Wisconsin, and Marblehead, Kelley's Island, Toledo, and Sandusky, Ohio (Table I).

Michigan usually ranks second only to Pennsylvania in annual production of limestone. Production for all purposes in 1937 totalled 15,445,211 tons, of which approximately 83 per cent was transported by lake boat. A considerable part of the remainder moved to market by boat as cement from plants of the Huron Portland Cement Company at Alpena and the Petoskey Portland Cement Company at Petoskey.

In the production and distribution of a cheap, bulky commodity such as crushed and broken stone, the first requisite is low cost. As discussed previously in Economic Geography, Vol. 18, No. 3 (1942), low production costs are obtained in Michigan quarries by the use of highly mechanized, large-scale methods. Low distribution costs have resulted from the lakeside location of extensive, thick, level, and nearly pure deposits of high calcium limestone under thin overburden. Cheap transporta-

TABLE I

LAKE SHIPMENTS OF LIMESTONE
TOTAL SHIPMENTS AND SHIPMENTS FROM MAIN PORTS OF ORIGIN*
(Net Tons)

Year	*Calcite, Michigan*	*Rockport, Michigan*	*Alpena, Michigan*	*Port Inland, Michigan*	*Sturgeon Bay, Wisconsin*	*Kelley's Island, Ohio*	*Marblehead, Ohio*	*Sandusky, Ohio*	*Total Lake Shipments**
1908	.....	.....	105,200(A)	.....	158,375(C)	.....	.....	.....	.....
1909	.....	.....	359,729	.....	174,906	.....	.....	.....	.....
1910	.....	.....	437,220	.....	108,408	.....	.....	.....	.....
1911	.....	.....	427,400	.....	63,765	.....	.....	.....	.....
1912	No Record(B)	.....	498,153	.....	40,963	.....	.....	.....	.....
1913	1,232,000	.....	559,316	.....	77,481	.....	.....	.....	.....
1914	1,702,400	.....	616,500	.....	117,359	.....	.....	.....	(A)
1915	2,600,000	.....	650,590	.....	121,203	.....	.....	.....	3,854,106
1916	3,205,014	.....	302,820	.....	96,919	.....	.....	.....	5,553,927
1917	4,088,285	.....	891,048	.....	116,025	.....	.....	.....	6,748,801
1918	4,225,000	.....	915,900	.....	24,623	.....	.....	.....	7,467,776
1919	4,475,000	.....	561,334	.....	35,694	.....	.....	.....	6,407,285(x)
1920	6,514,459	.....	767,645	.....	97,178	(A)	.....	.....	7,821,980(x)
1921	3,477,504	.....	305,587	.....	173,600	17,000	(A)	.....	3,925,705
1922	5,919,802	(A)	679,279	.....	167,366	437,360	68,052	.....	7,592,137
1923	7,608,128	955,067	654,903	.....	197,887	576,980	31,402	.....	9,920,422
1924	6,856,291	1,189,618	705,658	.....	213,830	359,588	29,547	.....	9,225,624
1925	8,452,194	1,414,617	747,291	.....	329,234	518,870	31,805	.....	11,351,948
1926	9,041,301	1,847,413	836,763	.....	379,678	216,487	24,262	.....	12,628,244
1927	10,345,422	1,760,244	754,726	.....	367,557	486,171	78,979	.....	14,033,376
1928	11,136,503	1,985,502	955,874	.....	470,741	280,345	84,544	308,750(B)	15,677,551
1929	10,694,292	1,790,170	1,001,027	.....	1,036,217	433,525	55,162	530,835	16,269,612
1930	8,660,312	1,091,732	878,448	47,022(B)	761,711	365,266	109,814	248,774	12,432,628
1931	3,753,400	519,121	1,005,859	766,311	209,505	175,368	44,515	137,163	7,208,946
1932	1,322,764	167,944	1,474,184	230,442	196,050	96,820	36,982	129,907	3,928,840
1933	2,642,835	201,882	1,921,708	919,539	75,172	285,108	150,613	90,945	6,664,629
1934	3,207,572	233,678	.....	999,936	172,011	279,814	112,159	103,390	7,392,218
1935	3,868,326	657,229	1,749,485	1,597,868	62,947	350,237	123,269	59,296	9,082,155
1936	5,492,434	757,328	2,024,852	2,141,125	122,672	376,943	477,375	66,350	12,080,672
1937	7,307,780	735,373	2,209,305	2,426,741	207,685	365,145	477,179	73,667	14,429,379
1938	3,269,229	416,197	1,519,523	1,441,010	353,517	204,139	398,844	115,897	8,240,768
1939	5,980,065	530,914	1,896,952	2,585,793	235,427	134,851	497,562	101,063	12,208,205

(A) No previous record.
(B) First year of shipment.
(C) First record of shipment was 10,000 cords in 1888. In 1890, shipments totaled 280,000 tons, and in 1900, 202,268 tons. Amounts during other years before 1908 were smaller.
(x) Incomplete—includes amounts from only three quarries.
*Compiled from *Annual Reports of the Chief of Engineers*, U. S. Army, except for the Total Lake Shipments which were compiled from *Annual Reports Lake Carriers Association*.

tion afforded by the Great Lakes has been facilitated by the establishment of several large private harbors with highly mechanical loading equipment, and the development of self-unloading boats of a special type.

HISTORICAL ASPECTS

Transportation of stone on the Great Lakes had an early beginning. John A. Clemons began quarry operations on Kelley's Island, then known as Cunningham's Island, in 1833. In 1834, stone valued at $800 was shipped in the vessel "Ben Franklin," built for hauling stone and cedar from the Island. For years Kelley's Island limestone reached markets throughout the Great Lakes region, but more recently, shipments were largely destined for Lake Erie points. Early in 1941, the owners of this historic quarry, the Kelley Island Lime and Transport Company, announced that the quarry would remain closed indefinitely, with demands for stone being supplied from company properties at nearby Marblehead.

Quarrying at Marblehead no doubt began when John Clemons, having soon disposed of his Kelley's Island holding, came to Marblehead and again engaged in the stone business. Boat shipments

from Marblehead probably started sometime in 1834 or 1835; rail shipments when the Lakeside and Marblehead Railroad began operations about 1887.

As early as 1888, ten thousand cords of stone were moved by water from Sturgeon Bay, Wisconsin. Two years later such shipments totaled 280,000 tons. Cargoes from Sturgeon Bay during earlier years were largely blocks for crib fill, rubble, riprap, and building, but shipments of crushed stone, which began about 1910, have been dominant since about 1920.

Despite these early beginnings in Ohio and Wisconsin, however, the development of the stone trade on the Great Lakes to its present stature is essentially a reflection of the development of the Michigan limestone industry. The first Michigan quarry to ship any appreciable amount of limestone by water, though by no means the first to make use of this medium of transportation, was that of the Michigan Alkali Company at Alpena (Figure 3). This quarry was opened in 1903, but boat shipments, of important amounts of stone at least, did not begin at once. In 1908, the first year of available records, 105,200 net tons were moved by water. Four years later, in 1912, almost 500,000 tons were shipped.

That same year, the Michigan Limestone and Chemical Company quarry was opened near Rogers City at Calcite. The next year this quarry alone shipped 1,232,000 net tons of stone by boat. Thus, 1913 may be used to mark the beginning of large-scale shipments of stone on the Great Lakes. Of the 3,854,106 net tons of stone moved by water in 1915, the first year for which figures are available for the total volume of trade, some 3,250,590 net tons originated at Calcite and Alpena.

Water shipments from Rockport began with the opening in 1915 of the

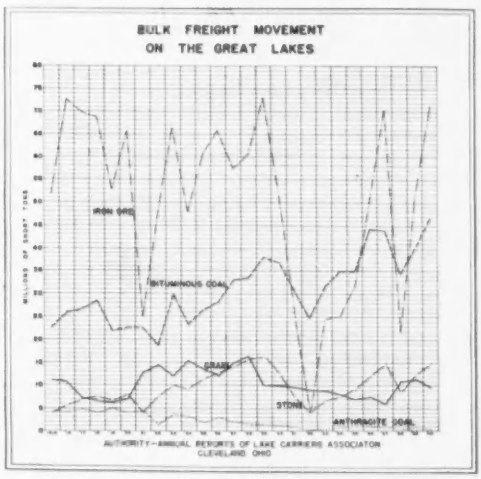


FIGURE 1.—Bulk freight moved on the Great Lakes during 1941 in net tons was: iron ore, 89,730,323; bituminous coal, 49,733,234; stone, 17,633,448; grain, 11,387,480; and anthracite coal, 536,490. The total, 162,020,975 net tons, exceeded that for any previous year. Records were broken in the shipments of iron ore, stone, and bituminous coal.

Great Lakes Lime and Stone Company quarry (later purchased by the Kelley Island Lime and Transport Company). Shipments from the Inland Lime and Stone Company quarries at Port Inland began in 1930, and from the Thunder Bay Quarries Company quarry at Alpena in 1931. Meanwhile, the Wagner Quarries Company had dispatched the first cargo of stone from its new dock at Sandusky, Ohio, in April, 1928.

The ports discussed above have been the most important sources of stone carried, although stone has at one time or another been shipped from other Great Lakes points, as for example, Drummond Island, Michigan; Belgium, Wisconsin; and Toledo, Ohio.

LAKE TRANSPORTATION UNITS

Two main types of lake boats transport stone: (1) the ordinary bulk freighter; (2) the self-unloading boat. Small amounts are also carried by barge.

The Bulk Freighter. The ordinary bulk freighter, designed primarily as an

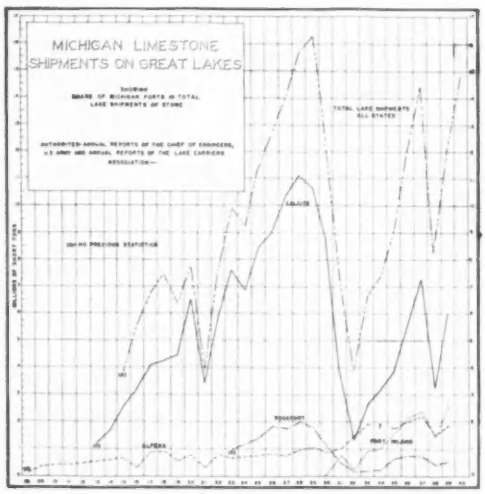


FIGURE 2.—The importance of Michigan limestone in the stone trade on the Great Lakes is clearly apparent from the above graph.

iron ore carrying vessel, is also suitable for moving the other important bulk cargoes. Designed to move a maximum amount of cargo during the restricted navigation season, at a minimum cost per ton on voyages of 1,000 miles or less, the ordinary lake freighter is unlike most ocean vessels. It is a long, narrow, heavily-constructed, parallel-sided, steel box, ship shaped at the ends. It is unusually long in comparison to its width and depth, because of restrictions imposed by the width and depth of channels and locks traversed. Propelling machinery is aft, pilot house and bridge fore, quarters for officers and men both fore and aft, leaving a long clear hold space between, which is interrupted only by two or three non-watertight bulkheads.

Ordinary speed loaded is eleven miles per hour; light it is nearer twelve miles. Propelling equipment of about 2,000 to 2,500 horsepower is used, operating on a consumption of 1.6 to 2.0 pounds of coal per indicated horsepower per hour. The small coal consumption per ton mile of cargo carried is an important factor in making the low freight rates possible. The standard sized newer vessel has a length of 600 feet, a 60-foot beam, a depth of 32 feet, and a carrying capacity of 12,000 gross tons on a 20-foot draft. A few vessels are larger; many are smaller since lack of deterioration of hulls in fresh water permits operation of older boats indefinitely. (See articles by A. H. Jansson in *Marine Engineering and Shipping Review:* "Improving the Lake Ore Carrier," Vol. 41, No. 3, 1936, p. 151; "Bulk Freighters," Vol. 41, No. 11, 1936, p. 645.)

There are some 300 bulk freighters in the American iron ore fleet. All could carry limestone, but only boats of certain companies are commonly used for this purpose and then only part time. Freighters of the Pittsburgh Steamship Company, a subsidiary of the United States Steel Corporation and the largest fleet on the Great Lakes, probably carry more stone than do the freighters of all other companies. Stone transported by this company largely originates at Calcite.

The Self-Unloading Boat was developed for handling crushed and broken limestone on the Great Lakes, but its usefulness for handling coal as well soon became apparent. Use in both trades has steadily increased. Self-unloaders are also used for transporting sand, gravel, cinders, coke, and gypsum, but not yet for grain or iron ore. Other self-unloaders of types not considered here, handle only sand and bulk cement.

The self-unloading boats used in the stone trade are of two classes: (1) boats originally designed and built as self-unloaders; (2) bulk freighters converted into self-unloaders by hold changes and the addition of unloading machinery. The basic ideas are the same in either class.

Briefly stated, the cargo hold is built with a bottom approximating in cross section the shape of a flattened "W."

Beneath the two base points of the "W" are tunnels running lengthwise of the ship. Hand or electrically operated gates drop stone into these tunnels from the cargo space. In the tunnels, belt conveyors or drag line scrapers carry the stone forward to an inclined conveyor near the prow. This discharges to a belt conveyor, mounted on a boom which can be swung from the boat out over the delivery point (Figure 4).

15-foot draft, the then available depth at the Alpena dock. Between 1908 and 1924, eight other new self-unloading steamers were built. (Jansson, A. H., "Self-Unloaders on the Great Lakes," *Marine Engineering and Shipping Review*. Vol. 41, No. 6, 1936, p. 319.)

The first conversion of an ordinary bulk freighter into a self-unloader, the "Fontana," was completed in 1924, using drag line scrapers in the hold for the first time. Within a few years a

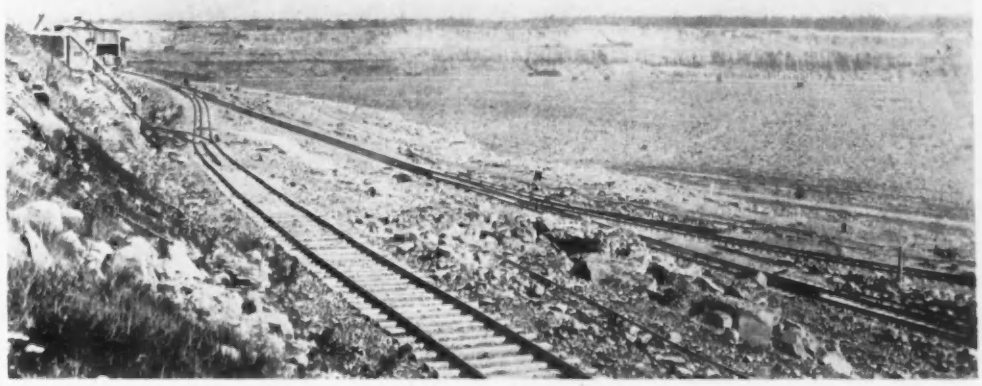


FIGURE 3.—Part of the Michigan Alkali Company quarry at Alpena. Roughly oval in shape, the pit is about one-half mile wide, two-thirds of a mile long, and a maximum of 100 feet deep. Two levels are worked. Forty to fifty million tons of stone have been removed, largely for use in the alkali and cement industries. (Photo by L. Claire Hulbert.)

The pioneer belt conveyor type of self-unloader, the "Hennepin," a wooden vessel with a capacity of 1,000 tons of stone, was put in service in 1902, by the Lake Shore Stone Company, Belgium, Wisconsin. The "Topeka," another wooden self-unloader was put in service by the same company in 1905. (Harsh, E. C., "Self-Unloading Boats," *Rock Products*, Vol. 34, No. 26, 1931, p. 20.) Not until 1908, however, was the "Wyandotte," the first modern type self-unloading steel vessel, commissioned. Built for transporting limestone from Alpena to Wyandotte, this vessel carried about 3,300 net tons of stone on a

number of standard freighters were converted by this method. More recent conversions, however, have made use of the belt conveyor method. Many of the early conversions were on older, smaller, relatively inefficient ore freighters, but later conversions have been on larger boats.

Some 35 self-unloaders of the type considered now ply the Great Lakes, to which waters they are almost unique since only two or three similar vessels operate along the east coast in the coal trade. All are converted freighters, except about a dozen originally built as self-unloaders. Rated cargo capacities

range from 2,500 to 14,000 tons. The "Carl D. Bradley," until recently the largest boat on the Great Lakes, was constructed as a self-unloader (Figure 5).

Conveyor booms on the self-unloaders have a swinging radius up to 226 degrees and are of varying lengths. There has been a tendency to make them longer, making possible the addition of height and tonnage to dock storage piles. With the longest booms used, material can be carried almost 200 feet beyond the side of the boat. Boom tips can be raised or lowered to accommodate the delivery point on the shore.

Unloaders thus have great adaptability for discharging cargo. They are independent of shore equipment, and of shore labor conditions and fixed working hours. They lower land freight charges by depositing the cargo on the dock nearest its final destination. Different sizes of stone from different compartments in the boat can quickly and easily be unloaded on separate storage piles, or at different delivery points if need be. As a result, these boats have made accessible to the lakeside quarries markets which could not otherwise have been reached.

Furthermore, the speedy unloading results in short stays in ports, thus cheapening transportation costs. The newer self-unloaders discharge stone at rates of 2,000 or more tons per hour (coal a little over half as fast). The "Carl D. Bradley" has discharged 15,633 gross tons of stone in five hours and twenty-one minutes, at the rate of 2,922 tons per hour, setting a record for the unloading of limestone. The short stay in port adapts the self-unloader to the relatively shorter voyages which stone or coal usually make as compared to grain and ore. The self-unloader "Huron" has moved 130 cargoes and 922,833 net tons of freight in a single season, extending from April 1 to December 1, 1928. This was an all-time record for number of cargoes and tonnage carried on the Great Lakes, and consisted of 73 cargoes of soft coal, aggregating 442,019 tons, and 57 cargoes of stone, aggregating 480,814 tons.

FIGURE 5.—The self-unloader "Carl D. Bradley" loading crushed limestone at Calcite. Note harbor tug. With a tonnage of 10,028, a length of 615 feet, a breadth of 65 feet, and a depth of 33 feet, the Bradley was until recently the largest boat on the Great Lakes. It has carried 18,114 net tons of limestone on a single trip. The "Leon Frazer," an ore carrier launched February 28, 1942, and the first of five identical sister ships, is larger, having a tonnage of 10,450, a length of 639 feet, a breadth of 67 feet, and a depth of 35 feet. (Courtesy of the Michigan Limestone and Chemical Company.)

FIGURE 4.—The self-unloader "George F. Rand" discharging coal at the Petoskey Portland Cement Company dock, Petoskey, Michigan.

Self-unloaders most commonly engaged in the transportation of stone from Michigan quarries are the boats of the Bradley Transportation Company, moving stone from Calcite, and those of the Wyandotte Transportation Company and of the American Steamship Company, moving stone from

Alpena. Itineraries are not fixed, but it is natural that the self-unloaders make certain trips more often than others. Common trips for Wyandotte Transportation Company vessels, for example, are between Alpena and Wyandotte with stone, and between Toledo and Wyandotte (or Detroit) with coal.

Jansson has stated that probably 33 per cent of all shipments of stone on the Great Lakes is moved by self-unloaders. (Jansson, A. H. "Are New Ships Needed On the Great Lakes?" *Marine Engineering and Shipping Review*, Vol. 41, No. 1, 1936, p. 11.) Information obtained by the writer indicates that practically all stone shipped from Alpena, and about a quarter of that from Port Inland, is moved in this manner. Percentages of stone shipped by self-unloader from other quarries were not learned.

PORT AND PORT FACILITIES

Without adequate harbors equipped with efficient loading and unloading machinery, the Great Lakes would be of little use to the quarry industry. Two of the four large private harbors on the Lakes, those at Calcite and Port Inland, were developed by limestone companies, while a third, the harbor of the Universal Atlas Portland Cement Company at Buffington, was constructed primarily to receive limestone shipments. The fourth harbor, at Gary, also receives limestone in addition to iron ore and coal. Large expenditures have been made by other quarry companies on lesser harbor improvements and on dock facilities. Only large companies could afford such investments, which in turn have been warranted only by the tremendous amounts of limestone thus made available for shipment and use. For descriptions of the harbors of the different shipping and receiving points, the reader is referred to, "Survey of Northern and Northwestern Lakes," Bull. No. 50, War Dept. Corps of Engineers, Washington, 1941.

Stone from Michigan quarries is loaded into boats by shuttle belt loading equipment at rates of from 1,000 to 3,600 tons per hour (Figure 6). Older type pocket docks at two quarries have been modernized by the addition of loading shuttles (Figure 7).

Stone receiving harbors have been largely developed in connection with the iron ore, coal, grain, and other trades. Stone transported by ordinary bulk freighters is commonly unloaded by the same shore equipment used for unloading ore and coal. Large, heavy, and powerful, electrically operated machines quickly scoop the stone from the vessel hold and deposit it on stock piles or into railroad cars. One such machine can handle upwards of 1,000 tons of stone per hour, and the machines usually work in batteries of two or more.

FIGURE 6.—Pocket type loading dock of the Michigan Alkali Company, Alpena. Ends of the loading shuttles in retracted position can be seen midway between the water and the loading shutes formerly used. Coal delivered by boats returning from downlake is visible in the background.

Since limestone, like iron ore, is a dead weight cargo where carrying capacity increases with boat draft and full cargoes are the general rule, the depths of water in harbors and channels, and the fluctuation thereof, are very important problems of the trade.

TABLE II

ORIGIN OF STONE RECEIVED BY BOAT AT CERTAIN GREAT LAKE PORTS DURING 1938
(Net Tons)

Receiving Ports	*Calcite, Mich.*	*Port Inland, Mich.*	*Rockport, Mich.*	*Alpena, Mich.*	*Marble-head, Ohio*	*Sandusky, Mich.*	*Kelly Island, Mich.*	*Sturgeon Bay, Wis.*
Port of Chicago (1)	456,101	124,328	5,977	.....	.....	.....	.....	.....
Duluth–Superior (2)	199,930	4,078	.....	.....	.....	.....	.....	.....
Milwaukee	.....	20,374	.....	.....	.....	.....	.....	4,142
Port of Detroit (3)	857,211	250,685	.....	682,949	118,805	830	.....	.....
Lorain	264,892	.....	.....	1,411	8,177	3,320	.....	.....
Fairport	.....	.....	.....	800,778	1,718	8,261	.....	.....
Ashtabula	.....	.....	.....	.....	2,553	11,964	.....	.....
Cleveland	276,141	.....	16,066	17,461	193,517	42,730	65,998	38,978
Port of Buffalo	341,097	317,571	124,675	.....	64,993	.....	45,554	.....
Total accounted for	2,395,372	717,036	146,718	1,502,599	389,763	67,105	111,552	43,120
Total domestic shipments	3,199,661	1,403,757	416,197	1,519,523	398,844	115,897	204,139	327,063
Tons not accounted for	804,289B	686,721C	269,478	16,924	9,081	48,792A	92,587	283,943

(1) Includes Chicago and Calumet harbors and tributary waterways. Also received 62,481 tons via Illinois Waterway.
(2) Also received 8963 tons from Toledo, that being entire amount shipped from Toledo.
(3) Includes Detroit, Ecorse, Rouge River, Wyandotte, Riverview and Trenton, Michigan.
A Of this amount 250 tons were shipped to Lake Erie Islands and 48,542 tons to Erie, Pa.
B Receipts at Gary were 403,656 tons, at Buffington 174,871 tons and at Sault Ste. Marie, 157,941 tons or a total of 736,468 tons. Most of this stone probably came from Calcite.
C Receipts at Indiana Harbor were 474,922 tons. Most of this stone probably came from Port Inland.
Compiled from *Great Lakes Port Series (Revised 1939)*, Corps of Engineers, U. S. Army, Washington, 1939 and 1940, and *Annual Report of the Chief of Engineers*, 1939, Pt. 2, U. S. Army, Washington, 1939.

DIRECTION OF STONE MOVEMENT

Stone moves down lake. Only a small amount moves into Lake Superior; almost none into Lake Ontario. During 1937, receipts at Lake Michigan ports totaled 5,305,082 net tons, 4,899,484 tons of this reaching ports at the south end of the lake. Receipts at Lake Huron ports totaled 467,743 net tons; those at the Port of Detroit, which includes Detroit, Ecorse, River Rouge, and Wyandotte, 2,106,507 net tons; and those at Lake Erie ports, 5,114,719 net tons. Since most of the stone originating at Lake Erie ports moves to other Lake Erie ports or to the Port of Detroit, this stone must be subtracted from receipts at these ports in determining destinations of Michigan limestone. Shipments from Sturgeon Bay, Wisconsin, reach scattered destinations.

Some stone is exported to Canada. During 1937, this amounted to 385,019 net tons: 267,517 tons originating at Calcite; 27,827 tons at Port Inland; and 88,575 tons at Sturgeon Bay. A considerable part of the exports go to Sault Ste. Marie, and the rest to Port Colborne.

Large receiving ports in 1937 in order of importance were Calumet Harbor and River, Buffalo, Gary, Cleveland, Fairport, and Wyandotte. Over 1,000,000 net tons of stone were unloaded at each place. Together these ports received approximately 60 per cent of the stone moved by water. Four other ports, Indiana Harbor, Lorain, River Rouge, and Buffington, each received between 500,000 and 1,000,000 net tons. The ten ports named received almost 80 per cent of the stone shipped by boat. The origin of stone received at certain ports in 1938 is shown in Table II. For past receipts of stone at selected ports see Table III.

LOCATION OF QUARRIES FOR GREAT LAKES SHIPMENTS

Stone from Calcite is shipped to the far end of the Lakes. Location of the quarry near the geographical center of Great Lakes navigation is indicated in Table IV. The quarry at nearby Rockport is equally well located for

TABLE III

RECEIPTS OF STONE AT SELECTED GREAT LAKE PORTS, 1911 TO 1940*

(Net Tons)

Year	*Buffington, Ind.*	*Gary, Ind.*	*Indiana Harbor, Ind.*	*Calumet Harbor & River, Ill. & Ind.*	*Duluth & Superior Minn. & Wisc.*	*Detroit, Mich.*	*River Rouge, Mich.*	*Wyandotte, Mich.*	*Fairport, Ohio*	*Lorain, Ohio*	*Cleveland, Ohio*	*Buffalo, N. Y.(†)*
1911	.....	.....	.....	.....	68,466	.....	75,058	.....	.....	.....	443,207	34,065
1912	.....	.....	.....	.....	65,819	.....	125,000	.....	(B)	.....	220,845	210,915
1913	.....	.....	(B)	.....	47,353	.....	181,433	.....	103,812	50,688	312,016	446,817
1914	.....	.....	159,905	.....	55,106	.....	190,500	.....	183,186	50,856	355,362	230,512
1915	.....	.....	209,048	.....	274,418	.....	203,944	.....	159,572	31,784	458,309	534,005
1916	.....	.....	227,054	.....	385,442	.....	139,147	.....	232,203	57,959	555,333	846,538
1917	.....	.....	299,462	(B)	385,503	.....	150,000	.....	484,376	157,197	669,936	1,319,522
1918	.....	.....	409,247	1,284,108	335,664	.....	135,000	.....	505,683	103,328	646,627	1,380,984
1919	.....	.....	355,949	1,098,914	288,717	(B) (C)	65,700	.....	328,079	275,499	578,035	1,205,276
1920	.....	.....	423,465	1,622,717	439,900	392,146	438,891	.....	471,440	457,073	867,648	1,027,099
1921	.....	.....	215,936	504,145	317,411	344,558	383,495	.....	345,794	273,791	313,119	689,779
1922	.....	(B)	300,761	1,158,163	465,725	420,885	50,000	.....	517,147	435,222	811,735	1,244,238
1923	.....	1,047,889	334,625	1,662,634	575,501	567,750	133,450	.....	569,182	497,185	836,198	1,725,759
1924	.....	.....	445,865	1,263,711	501,831	583,216	373,001	.....	578,225	413,824	809,510	1,309,045
1925	.....	1,300,000	535,673	1,795,418	440,852	1,335,766	450,280	(B)	791,254	539,558	869,431	1,231,047
1926	(A)	519,500	756,980	1,981,735	419,805	1,169,934	720,220	823,065	822,561	556,824	1,038,277	1,362,070
1927	1,380,688	837,946	720,828	1,537,761	447,783	923,914	773,557	774,322	947,745	564,565	1,112,396	1,130,927
1928	1,682,820	1,350,328	1,236,000	2,500,000	415,003	773,616	720,127	955,874	1,082,665	593,783	1,025,821	1,748,058
1929	1,337,498	1,389,518	824,902	2,067,440	464,836	1,093,410	1,146,274	1,001,027	1,206,598	545,352	1,266,243	1,761,639
1930	1,247,943	1,062,246	751,772	922,229	495,681	618,338	765,039	878,448	865,371	549,267	827,045	924,748
1931	302,742	652,053	487,167	708,820	281,082	15,090	189,209	815,516	585,660	226,301	443,286	913,068
1932	55,377	185,447	93,205	321,996	102,148	none	118,372	606,502	657,267	28,750	332,932	252,698
1933	309,414	274,212	260,081	937,439	90,805	none	116,948	898,297	826,717	527,264	705,248	811,495
1934	305,153	576,017	742,443	657,667	96,501	45,903	371,199	768,099	719,462	297,334	658,978	766,110
1935	168,855	547,506	767,331	1,464,206	228,728	188,188	458,870	815,305	891,134	260,686	916,209	1,107,068
1936	475,753	835,968	886,557	1,545,840	440,655	261,046	503,180	945,016	962,190	470,570	1,202,001	1,799,345
1937	518,454	1,474,841	875,665	1,988,520	.....	406,515	645,327	1,054,665	1,076,277	680,698	1,212,746	1,943,920
1938	174,871	403,656	474,922	550,945	214,524	528,063	973,497	642,326	810,757	277,800	712,465	941,632
1939	565,757	688,701	1,014,480	1,222,964	.....	808,132	812,703	918,918	872,744	650,030	1,319,640	1,426,769

(A) Harbor completed in May, 1927.
(B) No previous available statistics.
(C) Includes statistics for Ecorse, Michigan.
*Compiled from *Annual Reports of the Chief of Engineers*, U. S. Army.
(†) Previous to 1922 some commerce pertaining to Buffalo was reported under "Black Rock Channel and Tonawanda Harbor."

shipments which are commonly made to both Lake Michigan and Lake Erie points. At Alpena, the Michigan Alkali Company quarry is 230 miles from its principal market in Wyandotte, and the Thunder Bay Quarries Company 344 miles from its principal market at Fairport. The quarry at Port Inland is the closest large Michigan quarry to Calumet and Indiana Harbor, ports to which large amounts of stone are shipped, but is farther than other Michigan quarries from Detroit, Duluth, and Lake Erie ports where considerable stone is also marketed.

The quarry at Sturgeon Bay, Wisconsin, has a distance advantage to ports on Lake Michigan, but the stone produced is a dolomite which does not compete in many markets with the high-calcium Michigan product. The quarries shipping from Sandusky, Kelley's Island, Marblehead, and Toledo, Ohio, occupy the most suitable locations to Lake Erie ports for which most of their water shipments are destined. This locational advantage is partly nullified, however, because these quarries are independent and several of the largest consumers along Lake Erie favor the products of subsidiary quarries farther away.

TRANSPORTATION COSTS

Limestone is a low priced, bulky commodity. A difference of a cent or two

TABLE IV

WATER DISTANCES BETWEEN
PRINCIPAL GREAT LAKE STONE SHIPPING AND RECEIVING PORTS†

Receiving Port	*Calcite*	*Port Inland*	*Rockport*	*Alpena*	*Kelley's Island*	*Sturgeon Bay*
Buffalo	514	630	489	479	221	725
Fairport	380	495	354	344	79	590
Cleveland	362	477	336	326	55	572
Lorain	345	460	319	309	29	555
Wyandotte	265	380	239	230	53	475
River Rouge	260	375	234	225	58	470
Detroit	254	369	228	219	62	464
Sault Ste. Marie	86	150	107	137	393	245
Duluth	480	545	501	532	788	639
Milwaukee	315	230	342	374	630	133
Calumet	380	304	407	439	695	219
Indiana Harbor	390	314	417	449	705	224
Buffington	390	314	417	449	705	223
Gary	392	316	419	451	707	226

Distances from Marblehead and Sandusky, Ohio, would be nearly the same as those from Kelley's Island, Ohio.
†From distance tables compiled by the U. S. Lake Survey Office and the various U. S. Army Engineer Offices in the Great Lakes Division.

FIGURE 7.—The Port Inland dock. Stone is carried by belt conveyor from tunnels under the stock piles, through the building in the foreground, to the loading building in the rear. The loading shuttle, to the left, can be raised or lowered, extended or retracted, as needed. On the right is one of several mobile stacking towers. These are attached to the screen house by belt conveyors and are used for stacking stone in the storage area to await shipment.

per ton in cost of transportation is significant. Because of this, and because stone transportation is highly competitive, shipping companies are loath to make exact rates public. Rates are arrived at by private negotiation between shipper and carrier. Of importance in determining the rate is the supply of shipping tonnage available in relation to demand for it.

Most stone is handled by shipping companies which, like the quarries, are subsidiaries of large consumers. In such cases, arrangements commonly provide substantially lower freight rates than those charged users who have no control over transportation facilities. However, rates generally in effect for the independent users do not exceed fifty to sixty cents per gross ton (about one-tenth of one cent per ton mile). The average value at the quarry of Michigan limestone in 1937 was 58 cents per gross ton. Communications from a number of widely scattered independent users of Michigan limestone reported delivered prices between $1.00 and $1.10 per gross ton. The cost of stone to consumers controlling producing quarries or transportation facilities is no doubt less.

MARKETS

Since the writer's knowledge is limited concerning the disposition of stone shipped on the Great Lakes from other than Michigan quarries, the discussion which follows will be confined largely to the Michigan produced limestone.

Lake shipments of stone have tended to parallel annual shipments of iron ore. It is noticeable, nevertheless, that stone shipments increased in 1927 while iron ore shipments decreased (Figure 1). Also that while iron ore movement in

TABLE V

ESTIMATED RECEIPTS OF MICHIGAN FLUXING STONE, RECEIPTS OF IRON ORE FOR LOCAL CONSUMPTION, AND ANNUAL PLANT CAPACITIES AT IRON AND STEEL PLANTS IN THE GREAT LAKES REGION FOR YEAR, 1937

Locality	*Plant Capacities (gross tons) (4)*		*Iron Ore Received (gross tons) (5)*	*Estimated Receipts of Michigan Fluxing Stone (short tons) (6)*	
	Pig Iron and Ferro-Alloys	*Open Hearth Steel*		*Blast Furnace*	*Open Hearth*
Detroit District	1,225,000	2,854,000	1,457,000	456,500	194,000
Michigan Charcoal Furnaces	77,000	.....	132,000	8,500	.....
Gary District	3,501,750	5,041,000	5,716,000	1,053,000	421,500
Chicago–Calumet District (1)	5,807,050	4,716,000	7,321,000	1,200,000	234,500
Indiana Harbor District	1,327,000	2,760,000	2,763,000	508,000	291,500
Duluth District	277,150	300,000	.....	100,000	(A)
South Shore Lake Erie (2)	3,265,100	3,200,000	4,554,000	815,000 (B)	335,000 (B)
Buffalo–Tonawanda District (3)	3,125,700	3,402,000	5,147,000	910,000	421,500
Sault Ste. Marie, Canada	675,000	600,000	418,000	143,000	39,500
Port Colborne, Canada	100,000	.....	153,000	13,000	.....

1. Includes Chicago, South Chicago, East Chicago and Joliet.
2. Toledo not included.
3. Includes Lackawanna.
4. Compiled from *Iron and Steel Works Directory of the United States and Canada*, American Iron and Steel Institute, New York, 1939.
5. Iron ore for local consumption—compiled from *Lake Superior Iron Ores*, The Lake Superior Iron Ore Association, pp. 334–336 and frontpiece map, Cleveland, 1938.
6. Estimated from statistics contained in *Annual Report of the Chief of Engineers*, U. S. Army, information obtained from certain of the quarry and iron and steel companies, and a consideration of plant capacities and receipts of iron ore for local consumption. The estimates are admittedly rough and in some cases may vary considerably from actual receipts.
A. Included under blast furnace flux.
B. Some of this stone, especially open hearth stone, moved to the interior.

1928 was considerably below that of 1916, stone shipments were almost three times as large. Two facts help to explain this lack of correspondence: (1) Michigan quarries have furnished an increasingly large proportion of limestone used for flux in lakeside iron and steel plants; (2) consumption of limestone for uses other than the manufacture of iron and steel has grown greatly (Figure 8).

Ninth among the states in the production of fluxing stone in 1912, fifth in 1913, third from 1914 to 1917, and second from 1918 to 1939, Michigan stood first in 1939 (Figure 9). A recent computation by the American Iron and Steel Institute showed that Michigan furnished 27 per cent (over 88,900,000 net tons) of all the fluxing stone used in the United States from 1919 to 1937 inclusive, ranking second only to Pennsylvania which accounted for 35 per cent of the total.

Indications are that practically all high calcium fluxing stone used in domestic iron and steel plants fronting on the Great Lakes is from Michigan (Table V). One exception, the Interlake Iron Corporation at Toledo, uses furnace flux from Bellevue, Ohio. In addition, stone from Kelley's Island and Marblehead, Ohio, is used in certain steel plants on Lake Erie, and a quarry at Gasport, New York, produces a small amount of flux for use in the Buffalo district.

Most Michigan fluxing stone is used in or near the lake ports to which it is delivered, though some moves to the interior from the south shore ports of Lake Erie. The cost of rail transportation to interior points is a limiting factor. There is also often a handling charge at the lake ports. Consequently, suitable furnace flux can usually be obtained cheaper from deposits near the interior steel plants than from Michigan. Some Michigan stone is used, however, because of its very high purity. To illustrate, about 50 per cent of the open hearth flux used by the Youngstown

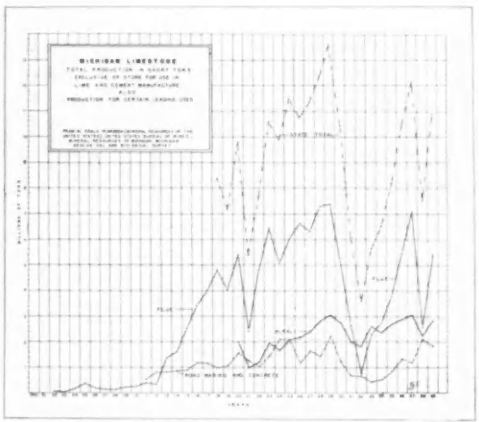


FIGURE 8.—Attention is called to the fact that stone produced for use in lime and cement manufacture is not included in the above graph. Such stone is reported in terms of lime and cement only. Since much stone produced in Michigan for these purposes is thus reported as lime and cement from other states, an erroneous impression is obtained concerning the relative importance of the quarrying industry in Michigan and other states concerned.

Sheet and Tube Company in the Youngstown district comes from Michigan.

Some Michigan flux is exported to Canada. The Algoma Steel Corporation Ltd., Sault Ste. Marie, has used Michigan stone since its founding in 1901. For many years this was obtained from a subsidiary quarry at Fiborn, Mackinac County, but because of high rail rates and obsolescence of machinery, this quarry was closed in 1935. Since then stone has been obtained from Calcite by boat. The delivered cost, it is said, is less than the rail rate from Fiborn alone. Canadian Furnace, Ltd., Port Colborne, has used certain amounts of Michigan limestone since its establishment in 1914. Normally about 50 per cent of the annual requirement is obtained from Calcite and Port Inland; the remainder from quarries at Beachville, Ontario. Properties at Beachville also supply the flux used at Hamilton by the Steel Company of Canada, Ltd.

Advantages enjoyed by the iron and steel plants along the Great Lakes are well known. Especially important are the low assembly costs for iron ore, coal, and limestone. Since the great metallurgical centers, and most of the plants, were established on the Great Lakes before the present large Michigan quarries developed, Michigan limestone deposits were not originally a major consideration in determining the location of most of the iron and steel centers. Extremely pure, produced at low cost, and cheaply transported by lake boat, Michigan fluxing stone soon offered inducements to its use, however, which enabled it largely to replace limestone formerly obtained from other states. Mention of a few instances illustrates the trend.

The South Chicago Works of the Youngstown Sheet and Tube Company started using Michigan fluxing stone in 1912; the Duluth Works of the American Steel and Wire Company in 1915; the International Harvester Company, Wisconsin Steel Works at South Chicago in 1923; the Lackawanna Plant of the Bethlehem Steel Company in 1923; the Tonawanda Iron Corporation at North Tonawanda in 1924; the Federal Furnaces of the Interlake Iron Corporation at Chicago in 1926; and the Susquehanna Furnaces of the Hanna Furnace Corporation at Buffalo in 1928.

Some 2,050 pounds of coke, 4,000 pounds of iron ore, and 900 pounds of limestone are normally required to make a gross ton of pig iron. The cost of limestone used to smelt each ton of pig iron in the lakeside plants is thus not more than 50 cents. Even though limestone is used in much smaller amounts than ore and coke, it can be concluded that availability of cheap Michigan fluxing stone has been an important factor in the economical operation of the lakeside iron and steel plants.

In the production of soda ash and allied products, the United States leads the world. Under good operating con-

ditions, the consumption of the principal raw materials per ton of soda ash produced has been given as salt 1.50 tons, limestone 1.20 tons, coke 0.095 tons, coal 0.41 tons, and ammonia 2 to 4 Kg. (Hou, Te-Pang, "Manufacture of Soda," *The Chemical Catalogue Company, Inc.*, New York, 1933, p. 278.) Thus an alkali plant to be well located must be near cheap and plentiful supplies of salt, high-grade limestone, and coal. Michigan quarries have long been the most important source of limestone for this industry.

Four alkali plants have used Michigan limestone. All are located over deposits of rock salt from which supplies of salt are pumped as brine. The Solvay Process Company at Detroit obtains limestone by rail from a company quarry at nearby Sibley. The Michigan Alkali Company at Wyandotte and the Diamond Alkali Company at Fairport obtain stone by boat from quarries at Alpena. The Columbia Chemical Company at Barberton, Ohio, uses stone from Calcite. This is received at Cleveland or Lorain by boat and forwarded by rail. The cost of rail transportation, 77 cents a gross ton, was doubtless a major reason why this company recently announced its intention of opening one of the deepest limestone mines in existence, adjacent to the Barberton plant.

The annual stone consumption of each alkali plant is not exactly known. Michigan quarries produced 3,034,356 tons of alkali stone during 1937. The same year, the Columbia Chemical Company used approximately 400,000 tons of Michigan limestone (Letter from company official). Considering the daily

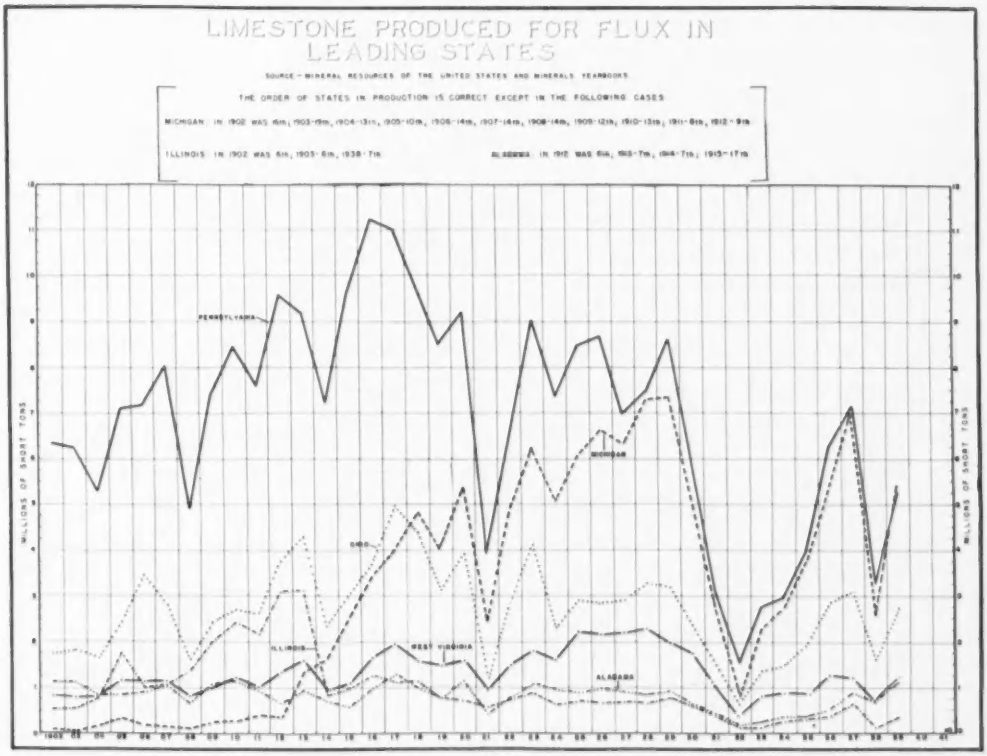

LIMESTONE PRODUCED FOR FLUX IN LEADING STATES
SOURCE - MINERAL RESOURCES OF THE UNITED STATES AND MINERALS YEARBOOKS
THE ORDER OF STATES IN PRODUCTION IS CORRECT EXCEPT IN THE FOLLOWING CASES
MICHIGAN: IN 1902 WAS 6th; 1903-05th, 1904-13th, 1905-10th, 1906-14th, 1907-14th, 1908-14th, 1909-12th, 1910-13th, 1911-8th, 1912-9th
ILLINOIS: IN 1902 WAS 5th, 1903-6th, 1938-7th
ALABAMA: IN 1912 WAS 6th, 1913-7th, 1914-7th, 1915-17th
PENNSYLVANIA
OHIO
MICHIGAN
ILLINOIS
WEST VIRGINIA
ALABAMA
MILLIONS OF SHORT TONS

FIGURE 9.—During the thirty-year period, 1910–1939 inclusive, Michigan rose from thirteenth to first among the states in production of fluxing stone for the iron and steel industry. Michigan produced only 1.2 per cent of the total national production of fluxing stone in 1910, but produced 33.2 per cent of this stone in 1937 and 31.2 per cent in 1939.

FIGURE 10.—Location of the several places concerned with Michigan limestone in the Great Lakes stone trade forms an important feature of the industry.

plant capacities in tons of alkali, consumption of the remaining stone was probably about evenly divided among the other three companies. Daily plant capacities as allocated by Hou in 1933 were: Solvay Process Company, 1,750 tons; Michigan Alkali Company, 1,800 tons; Diamond Alkali Company, 1,800 tons; Columbia Chemical Company, 1,000 tons (Hou, Te-Pang, op. cit., p. 34).

No record is regularly kept of the annual production of Michigan limestone for use in cement manufacture, but it is probable that this is usually exceeded only by production for fluxing stone and for alkali manufacture. All Michigan limestone produced for cement manufacture is delivered by lake boat except that used by the cement plants at Alpena and Petoskey (Table VI). Most of the larger Michigan quarries produce stone for cement manufacture. Out of some 2,904,955 short tons produced in 1937 for this purpose, over 1,158,095 tons were shipped outside of the state. This market is especially important since "fines," formerly a waste product, are commonly used. It is only necessary that these be low in magnesia, pyrite, and sulphur, and free from sand and flint.

Approximately 85 per cent of the limestone produced in Michigan during 1937 was for use in the industries discussed above. Proportions were: fluxing stone, 45.8 per cent; alkali, 19.6 per cent; and cement, 19.0 per cent. Another 7.7 per cent of the production was for use in making concrete and building roads.

Michigan limestone for road building and concrete has been widely distributed by boat along the shores of the Great Lakes. Michigan quarries face severe competition in providing stone for these two purposes, however, even to consumers in Michigan. Much stone has been shipped to Michigan, as well as elsewhere, from Sturgeon Bay, Wis-

TABLE VI

MICHIGAN LIMESTONE AND MARL
DELIVERED TO CEMENT PLANTS DURING 1937*

Company	*Plant Location*	*Plant Established*	*Limestone (short tons)*	*Marl (gross tons)*
Petoskey Portland Cement Co.	Petoskey, Mich.	1921	325,673	.....
Aetna Portland Cement Co.	Bay City, Mich.	1923	236,657	.....
Aetna Portland Cement Co.	Fenton, Mich.	1903	.....	Not obtained
Consolidated Cement Corp.	Cement City, Mich.	1901	24,472	166,707
Wolverine Portland Cement Co.	Quincy, Mich.	1900	.....	166,020
Wolverine Portland Cement Co.	Coldwater, Mich.	1898	.....	126,751
Peerless Cement Corp.	Detroit, Mich.	1925	275,543	.....
Peerless Cement Corp.	Port Huron, Mich.	1923	12,763†	.....
Ford Motor Co.	Dearborn, Mich.	1924	130,256	.....
Huron Portland Cement Co.	Wyandotte, Mich.	1899	Not obtained	.....
Huron Portland Cement Co.	Alpena, Mich.	1908	Not obtained	.....
Universal Atlas Cement Co.	Duluth, Minn.	1916	223,322	.....
Universal Atlas Cement Co.	Buffington, Ind.	1904	518,454	.....
Great Lakes Portland Cement Co.	Buffalo, N. Y.	1927	238,783	.....
Federal Portland Cement Co.	Buffalo, N. Y.	1927	102,542	.....
Medusa Portland Cement Co.	Manitowoc, Wis.	1924	74,994	.....
Standard Portland Cement Co.	Fairport, Ohio	1925	Not obtained	.....

*Based on written communications from officials of the various cement companies.
†Used from stock pile.

consin, and from the quarries along Lake Erie. The cheapness with which competing materials can be produced from widespread glacial deposits or from local rock outcrops also limits the use of Michigan limestone for making concrete and building roads. In 1937, for instance, Michigan County Road Commissions used over 3,750,000 cubic yards of gravel and only about 430,000 cubic yards of crushed limestone. Only a few counties, mostly those fronting on the Great Lakes or those lacking local gravel deposits, used limestone.

Included among other consumers of Michigan limestone are lime plants at Petoskey, Menominee, and Detroit in Michigan, and others at Buffalo, Duluth, Green Bay, and Chicago; thirteen sugar refining plants in Michigan, four in Ohio, and two in Wisconsin; a number of paper mills in Michigan and Wisconsin; carbide plants at Niagara Falls and Sault Ste. Marie; and fertilizer plants at Buffalo. Stone used by many of these consumers is received by boat.

From the foregoing it is apparent that Michigan quarries have played a major role in the development of the Great Lakes stone trade. That this trade will be of increasing importance in the future, especially during the war years, there can be little doubt.

BOOK REVIEWS

DAVIS, DARRELL H. *The Earth and Man: A Human Geography.* The Macmillan Company, New York, 1942. Price $4.25.

Among the many textbooks in geography which have come from the press in the last decade none serves better the purpose for which it is intended than this "The Earth and Man," a human geography. Its thirty-eight chapters divided into five major parts, its 410 illustrations, and 452 maps and charts present an abundance and variety of geographical material carefully selected and organized and clearly and convincingly set forth, that is almost incredible within the limits of one textbook, even though it exceeds 600 pages. It constitutes a veritable mine of geographical knowledge, such wealth of fact and principle and interpretation that even an indifferent teacher should have no difficulty in making his subject interesting if he uses the book as text.

"The Earth and Man" obviously represents well-nigh a teaching lifetime of close study of the field of geography, careful culling of the available literature, and testing out both fact and principle again and again in critical classes. For such a comprehensive book presenting such rich variety of fact gathered from such wide fields of human activity and human interest, and similarly such a wide range of literature on the subject, it would be too much to expect to find no errors at all; but they are so few and far between that criticism on this score would be captious. All in all, the abundant store of information that this book contains has been so judiciously selected and painstakingly authenticated that there is little which can not be substantiated directly in the field or in the library.

One of the outstanding features of the book is its logical organization, leading the student step by step from the land on which man lives up through the stages of his cultural development, to the present pattern of man's occupancy of his world and the present texture of interrelationships among the peoples of the many nations that have been made such near neighbors by modern improvements in transportation and communication. The book is a splendid example of the comparative-topical approach to the subject, a welcome relief from the exaggerated regionalism of the past two or three decades.

A clue to the organization and value of the book is obtained by listing the several parts and giving the proportionate space allotted to each. Part I. is a succinct, clear statement of the purpose of the book and the growth of geographic knowledge and field of geography, limited to fifteen pages. Part II., of six chapters and about ninety pages, is devoted to man and his environment. Part III., of fourteen chapters and about two hundred sixty pages treats of the limiting effects of environmental factors. Part IV., of twelve chapters and two hundred thirty pages, explains how man makes his living, and includes his occupations, his means of movement, and trade, and aggregation, and his population centers. Part V., the appendix, summarizes mathematical geography, climatic classification and weather predictions, soil classification, and agricultural and other regions, in five chapters that aggregate about seventy pages. For use as a collegiate textbook, "The Earth and Man" is one of the best that has appeared in our country. It is sure to receive the patronage that it deserves, and to supply teachers of geography in college with one of the books that they have long needed in the general field of human geography.

The book is well bound, well printed, richly and clearly illustrated, and shows throughout its craftsmanship the same attention to care and detail by the publishers, that the author has shown in the preparation of his text and illustrative material. Needless to say, it is an excellent book in every way.

W. E. E.

SEEMAN, ALBERT L. *Physical Geography.* Published by Prentice-Hall, Inc., New York, 1942.

The author of this new *Physical Geography* has chosen for his method of treatment a system that ought to work out excellently in practice. After discussion of each phase of physical geography, he presents an article written by some competent authority upon that phase which outlines the general principles of the topic. For instance, after his discussion of plains the author selects J. Sullivan Gibson's article "Land Economy of Warren County, Kentucky" as illustrative of a plains region. The author compacts and adapts the article, it is true, but brings out the essential elements in each one. By this ingenious method he is able to illustrate by excellent examples the principles that he sets forth in his academic text.

One paragraph from the author's preface, serves perhaps better than pages of description to state the purposes of his book and the plan by which it is organized.

"This textbook emphasizes the features of the earth such as climate, land forms, surface waters, soil, oceans, and all of the other elements of the environment. Then it summarizes the human activities for each particular element of the environment and presents a type study chosen from the geography journals for its excellence in discussing a specific place to illustrate a detailed relationship in one definite area. For example, there is presented a discussion of the types, characteristics, constructional and destructional processes of mountains and a general description of human activities found in mountains; then for a type study there was chosen an article about a mountain region, in this case, Peattie's study of Andorra. It has been found that students, after reading the type studies, are able to see the application of the

general principles to a definite area. The specific type study can then be used as an example for other small areas which may differ in detail; these differing details illustrate changes due to local physical characteristics. There is little mention of products. The emphasis is on the physical, and it has been kept geographic."

As a progressive successful step in the right direction, it should achieve widespread popularity among college students and even among high school students. It is on a level that would make it easily adaptable to advanced high school courses or beginning college courses. It is written entertainingly in a style that is very easy to read. It is of about the right size for a semester's work if compacted somewhat, and yet extensive enough to form the basis for a full year's work if that seems expedient. The author is to be congratulated upon having organized so satisfactory a book for teaching, and the publishers deserve approval and praise for having undertaken a textbook so different from the orthodox type.

W. E. E.

CHAPPLE, ELIOT, AND COON, CARLETON S. *Principles of Anthropology.* Henry Holt & Co., Inc., New York, 1942. Price $3.75.

Anthropology has progressed so rapidly and moved so far during the last few decades that only most recent books in the field are up to date. Many old and established textbooks on the subject must be relegated to the reference shelf because they no longer present adequate summaries of the science with which they deal. So many new facts, such wealth of new material, so many ramifications of the subject in new directions, and so many additional and enthusiastic workers in the field characterize the present period of the development of anthropology, that neither the teacher nor the student can manage to keep up with the rapid pace the science has set in recent years. Never before in its relatively brief history of about a century has anthropology expanded so fast as it has been broadening its field in the last decade.

Consequently new books are constantly needed for text and for reference. This topical survey by Professors Chapple and Coon supplies one of the most urgent needs. It will be of great value not only to the anthropologist but to the geographer, the sociologist, and every other scientist who is concerned with the broadening field of "human relation." Fairly new in its definition of its own discipline, anthropology has come to serve many other disciplines that are devoted to study of man's relationships to his land and his society. Its contribution to its related disciplines have become increasingly significant, until now a knowledge of anthropology is as vital to the students of related disciplines as it is to the disciples of the science itself. It is for this reason that "Principles of Anthropology" assumes a place in scientific literature that its predecessors have not held.

A review of the contents of the book reveals the diversity of its material. Part I. treats of biology and human relations. Part II. discusses the roles that environment and technology play. Part III. relates the development of institutions. Part IV. and Part V. are both concerned with symbols and human relationships. A comprehensive bibliography, an informative glossary, and an adequate index for reference complete the material of the book. In its physical make-up the book measures up to the best traditions of craftsmanship in composition, printing, and binding, of the publishing firm that issues it.

W. E. E.

RICH, JOHN LYON. *The Face of South America: An Aerial Traverse.* American Geographical Society, Special Publication No. 26, George Grady Press, New York.

Whenever the American Geographical Society publishes a book in its field it spares no pains or effort to make it superior; and whenever John L. Rich does a job of any kind, he does it extremely well. With these two premises established, the conclusion that "The Face of South America: An Aerial Traverse" written by Professor Rich and issued by the American Geographical Society, is superlatively done, is inevitable. As illustration of the value of the new science of photogrammetry and aerial photography, it is hard to surpass. South America lends itself very well indeed to exploration and interpretation from the air. With the fine beginning that Professor Rich has made in this volume, and other aerial photographers have achieved before him in some parts of the continent in their volumes, it should not be long until the whole continent has been photographed from the air, and mapped from those photographs.

As indicated by the first map in the book which shows the territory surveyed by the traverse, Professor Rich's work covers the coastal areas of the continent all the way from the Panama Canal southward to Santiago, Chile, thence across to Buenos Aires, Argentina, thence northward into Paraguay, and eastward to Sao Paulo, and thence northward along the coast again as far as Trinidad. Fourteen definite areas are delimited for each one of which a distinct part of the book is written, with photographs to depict them and text to elucidate them. Because Professor Rich is a happy combination of photogrammetist, geologist, and geographer, he succeeds in describing and interpreting the country included within the surveys as effectively as the time of his observations and the space of the book permit. With his characteristic thoroughness Professor Rich manages to compact within the limits of the volume and the limits of the survey an almost incredible amount of geographic information expressed both in the photographs and in the text. As a consequence the book becomes a most valuable contribution to our knowledge of South America and to the science of photogrammetry.

Like all the books in the special publication series of the American Geographical Society, "The Face of South America," which is the twenty-sixth in the series, is a fine example of craftsmanship in composing, printing, and binding. The paper is excellent, the type clear and legible, the photographs extraordinarily clear, and the binding the characteristic fine gray already so well known among geographers.

Maps of the flight route, and location, direction, and range of photographs aid in following the course of the survey, and a satisfactory index makes reference to the places named easy and quick.

W. E. E.

McGREGOR, JOHN C. *Southwestern Archaeology.* John Wiley & Sons, Inc., New York, 1941.

The same rapid progress that has characterized anthropology in recent decades applies as well to archaeology, both in general and in selected regions. Throughout the world a multitude of excavators has been at work uncovering a veritable bonanza of new and unexpected and unknown material for study, and for expansion of the science. By no means lagging behind the progress made in other parts of the world, American archaeology has marched on by leaps and bounds. Research has gone on rapidly and successfully in all parts of our great country, but it is in the Southwest, the semi-desert lands of our country, that the most startling discoveries and the most interesting relations have been made.

It is in our great Southwest that the fascinating technique of dendrochronology has been developed and applied to archaeological problems originally by Dr. A. E. Douglass, and following him by a goodly host of enthusiastic and conscientious disciples. Perhaps no other feature of anthropological progress has so effectively stimulated research and investigation, but the study of pottery methods and other artifactual industries such as basket making, pueblo building, stone chipping and polishing, textile weaving, irrigation agriculture and dry farming, and other similar activities have all lent their interest to the subject.

The work done in our American Southwest has now advanced to the point where the great mass of material accumulated and analyzed affords solid foundation for a comprehensive and logical, as well as chronological, presentation of the results obtained. A well-rounded picture is thus now obtained from the several elements when they are aggregated that enables us to understand the life of the peoples of the region throughout their whole occupancy. And this picture is excellently drawn for us in Mr. McGregor's book "Southwestern Archaeology" just recently off the press.

Everyone interested in archaeology, whether in Massachusetts or Mesopotamia, or Manchuria, as well as in New Mexico will find this book of interest. Almost the first hundred pages are given over to a general introduction to the definitions, aims, methods, and classification of anthropology. Dendrochronology and ceramics are both treated in special chapters. Most of the book, however, is devoted to description and interpretation of successive stages of culture represented in ruins of the southwestern United States, and there is keen satisfaction in following the sequence of cultural development there because there is very little doubt about the chronological succession, thanks to dendrochronology supported by pottery and other artifactual relics found in the ruins. The geographer has his own peculiar interest in the interpretations because they involve so many phases of his discipline and so many techniques of his science. Archaeology rebuilds and reconstructs not only history but geography as well. Geographers are just as much interested in the geography of the past as in the geography of the present because it helps them understand more satisfactorily the principles of their science. For this reason "Southwestern Archaeology" holds as much interest for the geographer as it does for the historian or the sociologist. Granting that the anthropologist and the archaeologist will be most effectively aided by this book, its further value to the allied sciences cannot be disputed or denied.

The author is to be congratulated upon a most interesting project, very ably executed—though perhaps not concluded because there is still so much to do and to learn; and the publisher is to be congratulated upon the fine craftsmanship that he has put into the material structure of the volume. The additional recommendation for this book is that it holds as much of interest to the layman as to the scientist. A banker or a baker, a farmer or a fisherman, will find the book a fascinating one to read, to entertain him, to educate him, and to broaden his field of knowledge.

W. E. E.

VON ENGELN, O. D. *Geomorphology.* The Macmillan Company, New York, 1942. $4.50.

Von Engeln's "Geomorphology" is one of the most valuable and timely contributions to the field of "geoscience" that has come from the American press these many decades. Almost encyclopedic in its treatment of factual material of the field, it includes both systematic and regional points of view, and embraces the whole field to which geomorphology relates. The author has long been recognized as one of the most thorough, painstaking, and critical workers in the field of geomorphology and his students have done some of the best recent work in all phases of that field. He has taught the subject at Cornell University these many years, and by his familiarity with the literature, his broad range of field studies, his sound judgment and keen observation, he sets the stamp of sound scholarship upon everything that he has done and presents in this volume. It is easy to understand from the author's long experience and his wide knowledge of his subject why the book is so comprehensive and so satisfying; it includes not only the limited science of land forms, but the broader science of the configuration of the earth as a whole and the disposition of its major units; it combines description, exposition, and interpretation; it is just the kind of book that the student needs to appreciate fully the forces and agencies and phenomena of geomorphology.

The factual content of the book itself is rich and varied, but at the end of each chapter the author gives a list of classical and recent references that enable the student to delve further into the subject matter of which each chapter treats. The style that the author uses is clear, untrammeled, and forceful. It holds the attention of the reader without any tedium or diffi-

culty. The volume is sure to take first place among the American textbooks on geomorphology, and to hold that place for many years.

Just as the author has done a fine task in writing the book, so the publishers have prided themselves in composing, printing, and binding it. Just as the author has made his illustrations, whether they be line cuts, halftones, maps, or charts, all pertinent and interesting, so the publisher has made them clear and legible and attractive. If there are any faults in the book, either from errors in text or faults of craftsmanship, they are so trivial as to be undiscernible. The many strong points of the book are obvious and indisputable.

W. E. E.

NEVIN, CHARLES MERRICK. *Principles of Structural Geology.* John Wiley & Sons, Inc., New York, 1942.

The third edition of Charles Merrick Nevin's "Principles of Structural Geology" represents a thorough revision of the old material in the previous editions, and includes the addition of a great deal of new material, as well as considerable refinement and classification of fact. The method of treatment is the same, but despite the expansion of its factual content, the book is thirty pages shorter than its earlier editions. Like the two previous editions the volume proceeds from the physical properties of rocks and stress and strain relations through flexures, faults, joints, and cleavage, to structures associated with igneous intrusion, structures in unconsolidated sediments, reflection of rock structure in topography, continents and ocean basins, and finally to mountain systems.

The book is as well bound and printed as its predecessors. It is indispensable to the general as well as the specialized geologist. Except in the chapters on the reflection of rock structure in topography, continents and ocean basins, and mountain systems, the volume holds relatively little interest for the geographer as such, though it may attract his general interest.

W. E. E.

WARD, HENRY B., Chairman and Editor; SEARS, PAUL B., AND BALLAM, CYRIL J., Committee on Conservation Education. *The Foundations of Conservation Education.* The National Wildlife Federation, 1941.

RENNER, GEORGE T. *Conservation of National Resources.* John Wiley & Sons, Inc., New York, 1942.

In "The Foundations of Conservation Education" Henry B. Ward, Chairman and Editor, and Paul B. Sears and Cyril J. Ballam, who constitute the Committee on Conservation Education of the National Wildlife Federation, present to the teachers of our country an excellent summary of the major fields of applied conservation. Wesley C. Mitchell of Columbia University writes the chapter on the relationship between conservation, economics, and liberty. W. C. Lowdermilk of the United States Soil Conservation Service contributes the chapter on conservation of soil as a natural resource. Paul B. Sears of Oberlin College outlines the essentials of conservation and Arthur N. Pack, head of the American Nature Association, the pitfalls of conservation. W. W. Horner and Richard W. Horner explain the role of applied science in conservation and its relation to wildlife. And finally, Henry B. Ward, for many years Secretary of the Association for the Advancement of Science, and emeritus professor of biology in the University of Illinois, discusses biology as the foundation of conservation education. All of these men are well acquainted with the problems and technique and benefits of conservation from actual experience in the field and many years of public service in the cause. They have their feet solidly upon the ground, and they walk familiarly in the intricate maze of pitfalls that jeopard sound conservation. Their book is final authority in applied conservation.

In "Conservation of National Resources," George T. Renner, Professor of Geography in Teachers College of Columbia University, builds up an educational approach to the problem that is based not so substantially upon actual contact and familiarity with it in its applied and actual form in the field and in the activities of the nation as upon a canvass of the literature, arbitrary classification of the aspects of conservation, and theoretical organization of the material that it involves. It helps the teacher crystallize out in his own mind for the use of his classes the manifold facts and principles of conservation and clarifies for them the significant relationships among the several phases of conservation and between those phases and man's activities.

The two books supplement each other. The latter is primarily technical, theoretical, and rather pedantic; the former is professional, practical, and in large measure factual. Both books are well bound, agreeably presented, and convincingly written.

W. E. E.

MILLS, LENNOX A. *British Rule in Eastern Asia.* The University of Minnesota Press, Minneapolis, Minnesota, 1942. Price $5.00.

A study of contemporary government and economic development in British Malays and Hong Kong. Here is a book with an original and amazing history. The first manuscript went to the bottom of the Atlantic. The second copy was split into three parts and sent across the ocean at different times under convoy. The book was printed between bombings in England and was ready for shipment to the United States on the day that the Japanese declared war. The first copies cleared the American customs in April 1942.

STARKEY, OTIS P. *The Economic Geography of Barbados.* Columbia University Press, New York, 1939. Price $3.00.

A study of the Barbadian environment in its relationship to the pattern of settlement and the standard of living of its people which summarizes the essential elements of the history of the Barbados as well as presents in detail its geography.

GRIFFIN, ROBERT A., AND SHAW, RONALD M., Editors. *School of the Citizen Soldier.* D. Appleton-Century Company, Inc., New York, 1942. Price $2.40.

A quasi-historical, quasi-geographical, quasi-military textbook for the citizen who wishes to be fairly well acquainted with the features of the present war emergency, and seeks to understand some of its underlying causes, its military strategy, and its intricate complications. A highly informative volume.

KLAGES, KARL H. W. *Ecological Crop Geography.* The Macmillan Company, New York, 1942. Price $4.50.

An interesting essay into the fields of ecology and geography by a professor of economy, who rather successfully relates the underlying principles of geographic distribution, ecological factors, and crop yields and distribution; probably of much value to the student of agronomy in a college of agriculture, but of dubious value to the biologist, the sociologist, or the geographer.

FAVILLE, DAVID E., JONES, DIX M., AND SONNE, RICHARD B. *Merchandise Availability in Utah.* Stanford University Press, Stanford University, California, 1942. Price $3.00.

A study of merchandising in rural communities that involves some of the economic implications of geography. Though probably of more interest to the economist and the sociologist than to the geographer, it does throw light upon some of the geographer's problems of distribution and processing of economic products.

SIMUTIS, ANICETAS. *The Economic Reconstruction of Lithuania After 1918.* Columbia University Press, New York, 1942. Price $1.50.

A regional study of Lithuania which includes agriculture, industry, foreign trade, finance, and brief discussions of the historic background, population pattern, the land and its resources, and climate of the country, all from the economic point of view rather than the geographic. It is a valuable contribution to the literature of a state about which altogether too little is known.

GARDNER, VICTOR R. *Basic Horticulture.* The Macmillan Company, New York, 1942. Price $3.75.

Essentially technological and limited strictly to the field which its title commits it to cover, this book has only remote and incidental significance to the geographer.

BENNETT, HUGH HAMMOND, AND PRYOR, WILLIAM CLAYTON. *This Land We Defend.* Longmans, Green and Co., New York, 1942.

Of the many books that present the scientific justification for conservation as related to this war, in a popular way, this volume, brief and written for propaganda as it is, has considerable value to our citizenry, and may form a valuable addition to the reference library of a conservation geographer.

Economic Atlas of the Pacific Northwest. Edited and published by The Northwest Regional Council, Portland, Oregon, 1942.

Already issued in a second and somewhat revised edition which also includes the textual and statistical explanation and interpretation of the maps which the first issue contained, this valuable addition to the regional literature of the Pacific Northwest cannot be assessed too highly as a geographic contribution to the literature of our country. As we come to know better and better the various sections of our great land, we shall be able the better to understand their problems and to plan for the integration of all the regions into one socio-political group having an interrelated economy.

GEE, WILSON. *The Social Economics of Agriculture.* The Macmillan Company, New York, 1942. Price $4.00.

Avowedly social and economic as the title of this book represents it to be, it contains some material and a great many implications that the geographer may put to good use in supplementing his own discipline and his own principles. The chapters on the rural-physical environment, rural population trends, and rural institutions contain perhaps the largest content of geographic implications in the book.

W. E. E.

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The July issue of Volume 18 contains the following articles:

The Rural-Urban Fringe, George S. Wehrwein, University of Wisconsin, Madison.
Agricultural Regions of Africa. Part III.—H. L. Shantz, Department of Agriculture, Forest Service, Washington, D. C.
Coal and Political Power in Europe, Walter H. Voskuil, Illinois State Geological Survey, Urbana.
Michigan Limestone Industry, Paul Cross Morrison, Michigan State College, East Lansing.
Cuyuna Iron Range, George F. Brightman, University of Minnesota, Minneapolis.
Potato Fed Swine in Germany, Earl Shaw, State Teachers College, Worcester, Massachusetts.
Population Changes in a Mountain County, Ronald L. Ives, 1428 Sixth Street, Santa Monica, California.
Ski Geography of New England, Albert S. Carlson, Dartmouth College, Hanover, New Hampshire.

The April issue includes:

Structure of Italian Agriculture, S. Van Valkenburg, Clark University, Worcester, Massachusetts.
Fordlandia and Belterra, Rubber Plantations on the Tapajos River, Brazil, Joseph A. Russell, Munitions Building, Military Intelligence, Washington, D. C.
Part-Time Farming and Recreational Land Use in New England, Roland B. Greeley, National Resources Planning Board, Boston, Massachusetts.
Localization of Sumatra's Oil Palm Industry, George F. Deasy, Clark University, Worcester, Massachusetts.
Wisconsin Cranberry Industry, Loyal Durand, Jr., The University of Wisconsin, Madison.
Soils and Farm Economy about Mount Warner, Massachusetts, Louis Kostanick, Clark University, Worcester, Massachusetts, and Merle Prunty, Jr., Mississippi State College for Women, Columbus.
Population Trends in Minnesota—1940, Leonard S. Wilson, Carleton College, Northfield, Minnesota.
Trends in the Pulp and Paper Industry, Sven A. Anderson, Rensselaer Polytechnic Institute, Troy, New York.
Geography of New England Soils, A. B. Beaumont, Massachusetts State College, Amherst, Massachusetts.
Declining Sugar Prices and Land Utilization in the British Lesser Antilles, Otis P. Starkey, Wharton School of Finance and Commerce, Philadelphia, Pennsylvania.

The January issue includes:

Ipswich, England, Chauncy D. Harris, University of Nebraska, Lincoln.
Water Power Resources in Brazil, Preston E. James, Latin-American Section, Office of Coordinator of Information, Washington, D. C.
The Florida Citrus Crop, Warren Strain, State Teachers College, Slippery Rock, Pennsylvania.
Synthetic Products and the Use of Soy Beans, Joseph A. Russell, Munitions Building, Military Intelligence, Washington, D. C.
Three City Ports of Denmark, W. R. Mead, with the R.A.F. in Canada.
Landscape Types along the Nuevo Laredo-Mexico City Highway, George F. Deasy, Clark University, Worcester, Massachusetts.
Tomato Industry of Indiana, W. D. Thornbury, Indiana University, Bloomington.
Borderland of the Wisconsin Driftless Area, L. H. Halverson, Northern State Teachers College, Marquette, Michigan.
Site of Early Los Angeles, Ruth E. Baugh, University of California, Los Angeles.
The Portales Region, the Llano Estacado, Alfred W. Booth, University of Illinois, Urbana.

The October issue of Volume 18 includes:

Brisbane—River Metropolis of Queensland, Clifford M. Zierer, University of California, Los Angeles.
Geography of the United States Cottonseed Oil Industry, George F. Deasy, Clark University, Worcester, Massachusetts.
Agricultural Regions of Africa. Part II—H. L. Shantz, Department of Agriculture, Forest Service, Washington, D. C.
Strategic Metallic Alloys and United States Dependence, Merle Prunty, Jr., Clark University, Worcester, Massachusetts.
Water and Northwest Missouri, Carol V. Mason, State Teachers College, Maryville, Missouri.
Alternative Sources of Rubber, Joseph A. Russell, Munitions Building, Military Intelligence, Washington, D. C.
A Reconnaissance of Some Cultural-Agricultural Islands in the South, Walter M. Kollmorgen, United States Department of Agriculture, Bureau of Agricultural Economics, Washington, D. C.

Single copies of back numbers of Volumes 1 to 5 inclusive will be sent to any American address for $1.75 each; to any foreign address for $2.00. Back numbers of Volumes 6 to 18 inclusive will be sent to any American address for $1.50 each; to any foreign address for $1.75. Whole volumes may be obtained at the yearly rate.

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DR. HOMER L. SHANTZ, Chief of the Division of Wildlife Management, United States Forest Service, will continue in subsequent issues his series of articles on the *Agricultural Regions of Africa*, which will conclude the extensive surveys of the world's agriculture, begun with Olof Jonasson's authoritative studies of the *Agricultural Regions of Europe*, and continued with Dr. O. E. Baker's similar studies on North America, Dr. C. F. Jones' exhaustive studies on South America, Dr. Griffith Taylor's corresponding articles on Australia, and the series on the *Agricultural Regions of Asia* by Dr. Samuel Van Valkenburg, Dr. George B. Cressey, and Dr. Robert B. Hall. In subsequent issues Dr. Samuel Van Valkenburg will complete the *Agricultural Regions of Asia*.

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